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EDITORIAL.

Engineering Items.

Transmitting power with economy.—Methods of applying mechanical force which are not, on general principles, economical, may, notwithstanding, from special conditions involved in particular cases, be highly useful and practically thrifty. Such, for example, would seem to be the case with the various "hoists" in which hydraulic presses are caused to operate what we might call inverted "mechanical powers," and of which so many examples are now presenting themselves in the world of mechanical invention. In all these, a high velocity in the pumping engine is converted into a low one in the press, only to be again reconverted into a rapid movement in the application to the machine. This change implies a loss incurred in the various intermediate machines; but the convenience of transmitting the power by this means, in certain cases, compensates for all. The power is, we may say, condensed for transportation, and expanded when it gets to its work. This is the very reverse of the method which has received the name of Teledynamic, (τῆλε far off, δύνάμις power,) where the force is transmitted at high velocities by very light running parts. An ex-

ample of this last is furnished in the "traversing cranes" of the Locomotive Works at Crew, (noticed in this Journal, Vol. LXIX., page 285,) driven by light cotton cords, running sixty miles per hour.

The same general principle is also about to be applied in some apparatus for the transmission of power from the engine-room to the hoists of the front premises of the Ledger Building, in this city, of which we hope, at a future time, to give a full account.

In each of these systems there is a loss,—in one case incurred in the act of transmission, from friction and the resistance of the air at these high velocities, and in the other, from loss of effect in the machines employed to transmute velocities at either end of the line.

In the cases, however, where an elastic fluid, such as air, is the transmitting medium, we have to add to the causes of loss last enumerated, the very important one of the energy expended in developing heat by the first compression, which heat is but imperfectly, if at all, recovered and utilized. That such a plan should prove of value, therefore, it is necessary that some especial adventitious benefit should be derived from the air employed, or the method must prove inferior to one of the others. In many cases of mining works, this may be derived from the supply of fresh air thus introduced. Such, no doubt, is the case in the Mont Cenis tunnel, where air, compressed by means of machines working on the principle of the hydraulic ram, is used to operate all the boring apparatus, while at the same time it provides thorough ventilation.

We meet with another example in the operations lately brought to a successful conclusion in the Ballarat mining district, New Zealand, as we learn from the *Mechanics' Magazine* for March, page 131.

At the mine of the Ballarat Tunnel Company, an engine has been erected at the mouth of the tunnel, for the purpose of compressing air, which is then carried into the interior of the mine, and employed at a convenient point to operate an engine, by which the lower workings are freed from water.

The compressed air is carried a distance of three thousand feet into the mine. As the authority above cited informs us, notwithstanding the jacket of running water with which the condensing air-pump is supplied, the first few hundred feet of pipe are nearly as hot as steam-pipe, while, on the other hand, the escape-pipe from the air-engine within the mine, is bearded with icicles. This reveals a serious loss, and were it not for the accidental advantage derived from the fresh air so introduced, there can be little doubt that this mode of

working would be found inferior in practical economy to other methods of transmitting power.

Surface condensers.—In a paper read before the English Institute of Naval Architects, by Robert Murray, C. E., we find some statements of great interest respecting the practical working of surface condensers, in connection with economy and the durability of boilers in marine engines. Referring our readers to page 365 of *Engineering* for full details, we may sum up the general conclusions as follows: 1st. The practical economy in the surface condenser depends essentially upon careful and moderate working of the engines, (by which means a good vacuum may be maintained,) and upon the high value of fuel, as in long voyages, by reason of which this item is made to assume large proportions. It is shown that for short and rapid trips, the use of surface condensers does not effect a good result; while on long voyages, as with the Indian mail steamers, the reverse is apparent, great care and intelligent management being included in this case.

2d. For the preservation of the boilers, it seems to be essential that a thin coating of scale should be produced and retained upon them. Failing this, the impurities introduced from the engine with the condensed steam, cause a very rapid corrosion and destruction of the plates.

To secure this protective coating, the boilers are filled with sea-water, and the density is allowed to run up to $\frac{1}{32}$ of salt, and is so maintained until a thin scale is deposited, after which the density is carefully adjusted to about that which is the natural condition of sea-water. A less density causes the re-solution of the scale, which, if removed, must be again deposited as above directed.

Hydraulic whipping hoist.—In the Journal above quoted, we find described, under the above title, a hoist in which an hydraulic press has for its plunger a hollow screw, with steep inside thread. This being prevented by guides from turning, gives a rotary motion to a long male screw fitting within it, and carrying a winding drum on its outer end, which is properly supported. The machine constructed by Messrs. Hayward, Tyler & Co., London, is simply another of those now numerous applications of an *inverted* "Mechanical Power" operated by an hydraulic press.

Direct acting cranes, by M. Chrétien, which seem to operate with great success, follow the above-mentioned general plan. Here a long steam cylinder forms the lower part of the jib, and its piston-

rod, by separating a system of pulleys, gives the required range of motion to the lifting chain.

The effect of sudden strains on bolts.—We learn from *Engineering* that Major Palliser has developed some very remarkable facts in connection with the above subject, which may be readily demonstrated by very simple means. A light iron tripod is arranged, from the centre of which hangs an iron rod nearly to the floor. A 28-pound weight, with a hole in the middle, slides on this rod, to the lower end of which the bolt to be tested is screwed, with a large steel nut at its lower extremity. The weight being allowed to slide, or rather drop, down the rod, is arrested by the steel nut, and so communicates the shock to the bolt. With bolts three-eighths of an inch in diameter over the thread and two and a half inches long between the attached portions, two falls of the weight broke the bolt at the bottom of the first thread from the body, the body of the bolt having in this case the full diameter above given throughout. But where the diameter of the body was reduced to one-fourth of an inch, one-half of the former section being thus removed, the bolt bore ten blows, and then broke in the body, after stretching three-fourths of an inch, or about thirty per cent.

Here we have the secret of the whole affair. The whole force was sustained, in the first case, in a single instant; while in the second, the stretching distributed it over a greater time.

Steel boilers are now coming pretty largely into use on the locomotives of some French railways. Thus, twelve express engines of the Paris and Orleans Railroad are thus furnished, as also several on that of Paris and Sceaux, and on the Midi or Southern Railroad fifteen eight-coupled engines have steel boilers. The Orleans Company now employs cast steel plates for the circular smoke-boxes of all their engines, new and old, steel being thus substituted for iron when repairs are made.

Pumping engines of the Harlam Lake.—In the number of *Engineering* bearing date April 26th, we find a very interesting drawing and description of one of the engines used in draining the Harlam River.

A full account of the topographical relations of the locality in question, and of the engineering works there constructed, will be found in the United States Patent Office Reports for the Department of Agriculture, 1855, page 122. The chief peculiarity of the engines above noticed is, that they were made with two concentric cylinders, the cen-

tral one having a circular, the space between an annular, piston. The central piston was connected by one, and the annular by four, piston-rods to the same massive cross-head, from which power was communicated by means of walking beams, in one case to eleven, and in two others to eight, pumps. A constant vacuum was maintained below the annular piston. Steam being admitted beneath the central one, raised the mass of pistons, cross-head, counter weights, &c., in all about eighty-five tons, and by an hydraulic apparatus these are supported at the summit of the stroke until the pump-valves have had time to adjust themselves, when the steam from below the piston is allowed by an equilibrium-valve to pass above it, and also over the annular piston, because the inner cylinder terminates one and a half inches short of the cover. The weights raised and the unbalanced pressure on the annular piston now effect the down stroke.

The outer cylinder is twelve feet diameter, the inner seven feet, the stroke ten feet. The pumps are seventy-three inches diameter and ten foot stroke. The engine is calculated to raise sixty-six tons of water at each stroke. The entire amount of water removed in draining the lake was, by calculation, eight hundred millions of tons.

Models of the Suez Canal and its constructive machinery.—In one of the auxiliary buildings of the Paris Exhibition are exhibited a complete set of models illustrating the above work. One large model shows not only the whole of the maritime canal, from the Mediterranean Sea to Suez, but also the fresh water one, which, taken from the Nile at Cairo, runs first to Ismailia, and then in a line nearly parallel with the other to Suez.

Models of various important parts, on a larger scale, are also shown, as well as very complete ones of the various machinery used in excavating and removing the material. One of these machines is somewhat of a novelty, being a dredging machine, mounted on a truck, which runs on a broad tram-way beside the canal, and, excavating as it goes, throws over the material taken out into cars, which are run upon a parallel track at the other side of the tram-way.

The Pacific Railway.—Three hundred tons of iron have arrived at Council Bluffs, for the use of the Union Pacific Railway, and eight hundred tons more are on the way. This road—following the Platte route—is expected to reach a distance of six hundred miles from the Missouri before the season closes.

The Interoceanic Railroad.—The Costa Rica Interoceanic Railroad Company has contracted with Colonel Edward McGovern,

of Pennsylvania, to superintend the survey of the route conceded to them by the Costa Rica government. Colonel McGovern was lately employed on the railroad between Vera Cruz and the city of Mexico.

The new enterprise with which he has identified himself looks to the construction of a new railroad connecting the Atlantic and Pacific Oceans, having excellent harbors at its termini, and passing through a healthy, productive and populous region.

The Missouri bridge.—One hundred men are at work at the bridge now being erected across the Missouri River at Kansas City, Missouri.

French Railways.—In 1866 there were in operation in France eight thousand six hundred and seventy-seven miles of railway, which is four hundred and twenty-six miles more than were in operation during 1865. The gross receipts of these railways, in 1865, were $112,450,000 in gold, and in 1866 $120,700,000 in gold.

A twenty-inch gun was cast at the Fort Pitt Foundry, Pittsburgh, recently. One hundred and forty thousand pounds (seventy tons) of the best Juniata iron were placed in three furnaces, the largest quantity in one being sixty-eight thousand pounds, and the remainder about equally divided between the other two. The fires were lighted at four and a half o'clock on Monday morning, and in three hours and a half afterwards the furnaces were tapped, and the molten metal began flowing through conduits at opposite sides into the mould, which was filled in twenty-seven minutes, during which time a stream of water passed in and out of the core barrel at the rate of twenty gallons per minute, the water increasing in temperature in ten minutes from sixty to one hundred and ten degrees, and in forty minutes to one hundred and twenty degrees.

The casting was accomplished successfully, and without the slightest accident. The weight of the gun in the rough, when taken from the mould, will be about one hundred and forty thousand pounds, and when finished ninety-five thousand pounds; its greatest diameter ninety-four inches, at the muzzle thirty-eight by seventy inches; length, one hundred and eighty-nine inches; bore, one hundred and fifty-seven inches. The gun is intended for navy service, and is considerably shorter than others of like calibre heretofore cast. When finished, it will be tested at the proving ground, for which a ball weighing one thousand pounds will be used; also, nine charges of mammoth powder, the first three of sixty pounds each, the next three of eighty pounds, and the last three of one hundred pounds each.

A large engine.—The largest and most powerful locomotive yet owned by the Camden and Amboy Railroad is now being built at the company's machine works, in Bordentown. It is a ten-wheel engine, having six drivers four and a half feet in diameter. The cylinder is seventeen inches in diameter, with a stroke of twenty-four inches. It will be finished in a short time. It is intended that it shall have sufficient strength to draw one hundred cars, laden with coal, in one train.

Iron trade of Cleveland.—The magnitude of the iron trade of which Cleveland, Ohio, is the centre, may be seen from the fact that in one week three million one hundred and eight thousand pounds were received at, and one million four hundred and seventy thousand pounds were shipped from, that city.

Enlargement of the Erie Canal.—A bill authorizing this enlargement has already passed the Senate and been referred to the House committee. It proposes to increase the depth of water to six feet, and to enlarge the locks to a length of one hundred and ten feet between gates, and a width of twenty feet, which will enable the canal to pass boats carrying from two hundred and twenty-five to two hundred and fifty tons. The expense of running boats of this size will be but little more than that of running boats of sixty-five tons burden, the present capacity of the canal. With this enlargement, the expense of transporting coal from the vast coal fields, to Erie, will not be more than one-half or one-third what it now is. The bill provides for an equitable payment of all damages arising from this enlargement, under the provisions of the railroad law of 1859.

The Dismal Swamp Canal is being dredged and deepened. Its width is also to be increased from forty feet to sixty, and its locks extended twenty-five feet. When these improvements are completed it will accommodate ten times the present amount of business.

Cleaning marble, &c.—A new process for cleaning the façades of public buildings and dwelling houses is now being experimented on in Paris. A steam engine supplies pipes of gutta-percha with a constant stream of the vapor. These are applied to the stone or the brick surface of buildings, one man directing the steam-jet and the other using a brush. The building, after the application of this system, looks as clean and new as when erected. A couple of men in three days will thus wash the façade of a hotel at a great economy of time and money over the old mode of cleansing.

The new deposits of black band ore.—Nearly three thousand tons of black band iron ore have been shipped over the Mill

Creek Railroad since the discovery of this mineral in Schuylkill county.

Large salt springs.—A vein of salt water was struck at Lawrence, Kansas, a few days ago, while boring for water for a woollen factory. The water yields one-half pound of salt to the gallon. At that yield, the business of manufacturing salt is considered profitable in that section. Arrangements are already made to commence the manufacture, and it is expected by fall one hundred barrels per day will be produced.

American breech-loaders.—Sweden has adopted an American breech-loader for the use of her armies. Austria, France and other great powers have rejected the American patterns on account of their cost, and the length of time required to adapt machinery for their construction, although their general superiority is freely acknowledged.

Mechanical improvements.—A French writer on America expresses his surprise at observing that, under certain conditions, a young man is known as "the beau," however homely his appearance. It would seem, in like manner, that "attentions" addressed to the Patent Office entitles all things to the designation of "improvements," however *little improving* in their character. We thus find in one of our contemporaries "*improvements* in rotary and reciprocating engines," which consist in placing within a cylinder a loaded piston, without piston-rod or other attachment, and, by pushing this with steam from end to end of the cylinder, which is mounted on trunions, causing this last to execute a system of summersaults as effective and useful as those of the toy known under the name of Chinese tumbler.

Standard for bolts and nuts.—Plates have been prepared by Mr. Edward Lyman, of New Haven, Connecticut, containing exact working drawings of the various sizes of bolts and nuts, according to the system recommended by the Franklin Institute, in a resolution adopted December 15th, 1864, and now very generally followed in our largest workshops. Impressions from these plates, on sheets of strong paper, at a cost which is about one-eighth of that which would secure a similar drawing, are supplied to those desiring them, Messrs. J. W. Queen & Co., of this city, being the agents in charge of the sales for this State. The above system has been adopted by the government works, and will no doubt soon become universal.

The Louisville bridge, which is to span the Ohio at that place, will be a grand structure. Its entire length will be about three thousand six hundred and fifty feet, with a pivot bridge across the canal of

two hundred and eighty feet. The exact location is not yet established; but it will be between what is called the Elm Tree Garden and Rock Island. It will be reached by a grade of about seventy-eight feet to the mile on each side, for the distance of nearly three hundred and fifty yards. There will be twelve spans of two hundred and fifty feet each, with one large span of four hundred feet across the Indiana chute. The bridge will have an elevation of ninety feet above low water mark, and forty-nine feet above high water mark. The superstructure, which will be entirely of iron, will be one hundred and fifty-two feet above the foundation, and thirty-two feet above the floor. The cost of the bridge will be but little over half as much as that of the suspension bridge at Cincinnati. The Louisville and Nashville and Jeffersonville Railroads have each $300,000 stock in it, and private parties have $400,000. Hands are now at work quarrying the stone for the bridge, and it is purposed to have it completed by the year 1870. The progress of the enterprise has perhaps been somewhat retarded by the opposition of certain parties in that city, who claim it will be an injury to Louisville, because freight and passengers will pass through the city without paying their re-shipping duties to commission merchants, hotel keepers, etc. It is barely possible that the business of a certain class will be injured by it, but there is not the least doubt that the city will be amply compensated for such injury by the influx of trade from the other side of the river.

Novelties in Chemistry and Physics.

Wonderful illustration of vegetable growth.—Mr. Ernest Baudrimont has made the following calculations with reference to a fungus, the Lycoperdon giganteum, which, in fourteen days from its appearance above the ground, had reached a globular development of three feet three inches in diameter, and a weight of nearly seven pounds.

To obtain the carbon, found in its structure, from the atmosphere, this plant must have acted upon about 32,130 quarts of air per day, or about one pint per second.

This whole plant is composed of minute cellules, of which it must

have contained more than 14,500,000,000. To develop these in fourteen days, the plant must, on the average, have produced them at the rate of twelve thousand per second. The idea is absolutely beyond the grasp of a finite intellect. Between two beats of a pendulum, twelve thousand organisms produced within the limits of a cubic yard.

Reflecting telescopes, of glass, silvered by Liebig's process, have lately received, at the hands of the well-known optician, Mr. John Browning, a great practical development. Compared with refractors, the instruments now furnished possess the following advantages. They are half the length, of greater dividing power, quite free of chromatic aberration, more convenient in position to the observer, from one-fifth to one-tenth the cost.

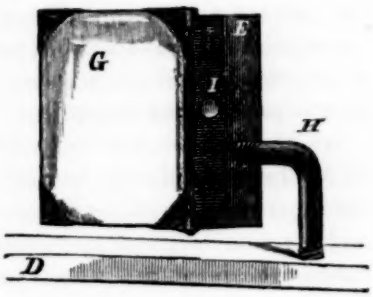
The silver surface, if tarnished, may be repolished by any one with a piece of soft leather; or if injured, can be replaced at a trifling expense.

Cheap lecture diagrams.—Under the above head we find in one of our contemporaries a description of the following plan. A sheet of paper is stretched on a board and then coated with a mixture of glue, water, lamp-black and ground pumice-stone. On this, when dry, the drawing is made with chalk and colored crayon, and fixed by going over the lines with water spray from an atomizer.

If a black ground is needed, this plan will no doubt prove satisfactory, but in all other cases we can recommend a far simpler one. If colors are required, draw on white paper with the wax crayons sold by the artist-stationers. We have for some time employed this plan, with great satisfaction, in the simpler description of diagrams, using for the more elaborate ordinary water colors. For mere black and white, the lithographic crayons used in drawing on stone make excellent diagrams, as we have lately seen from some prepared by Dr. C. M. Cresson, for his own use.

Multiple photographs.—To produce cheaply the small ambrotypes on varnished tin, which have been and are yet extensively manufactured, it is necessary to take, upon the same negative, many small repetitions of the same subject. This was formerly accomplished by using a camera with many lenses, and by exposing in this, in addition, different parts of the plate. This rendered the apparatus costly, the sitting long, and the manipulation difficult. A Mr. D. W. S. Rawson has removed these difficulties by a contrivance as ingenious as it is simple. He places opposite the sitter a box, filled with scraps of

looking-glass, each fastened to a block of wood, supported by a bent wire, as shown in the cut, so as to be readily adjustable. The camera, of any ordinary kind, with a single tube, is directed to these mirrors, and their multiple images are so taken. The account of this was first published in the *Philadelphia Photographer* for May, and we have since seen, at the office of its editor, Mr. Wilson, the apparatus and specimens of its work. The first strikes one by its simplicity, as does the second by its excellence. The error, due to double reflection from the two surfaces of the glass, is not appreciable.



New methods for the preparation of Oxygen.—From various publications lately made by the Abbé Moigno, in his own *Journal les Mondes*, and in the *Chemical News*, for which he has lately become the regular Paris correspondent, we learn many interesting particulars in reference to the above subjects. Thus, in the first place, he informs us, that a company, under the name of Jose de Susini & Co., with a capital of $400,000, has been formed in Paris, for the manufacture of oxygen under the patent of M. Archereau. This process, which we have before described, consists in the decomposition of sulphuric acid by heat, and the removal of the sulphurous acid by compression and consequent condensation, and by chemical absorption, leaving the oxygen in a pure state. The sulphurous acid is to be reconverted into sulphuric, by the usual process of the leaden chambers. From twenty-four pounds of sulphuric acid, of a density 60° Baumé, which is about the condition of that drawn from the leaden chambers before concentration, a cubic metre or 35·3 cubic feet (=two hundred and sixty gallons) of oxygen may be obtained.

It is calculated that by burning the ordinary illuminating gas with oxygen on lime, the amount of illumination obtained with a given quantity of the former, is increased about eight-fold, as compared with its ordinary burning in the atmosphere; while the increase in cost, by reason of the oxygen supplied by the process above, would be about four times, showing a gain of one hundred per cent. This calculation we have modified from that of the Abbé, who allows but half a measure of oxygen to each measure of burning gas. This, we sup-

pose, must be an oversight, as we know, from actual experience, that illuminating gas requires practically an equal volume of oxygen for its thorough combustion. The practicability of the above plan on a commercial scale, as the Abbé remarks, has yet to be proved, and the above correction of the previous estimate does not improve the prospect of profit in the enterprise.

Another process, to which allusion has been made before, is that of M. M. Tessié de Mothay and Maréchier, of Metz. This consists in the superoxidation of the manganate of soda by a current of hot air, and the deoxidation of the permanganate so formed by a current of steam. Each two and a half pounds of the salt will yield at each treatment about eighteen gallons of oxygen, and there is no waste of material. An apparatus working on this principle, and capable of yielding about one hundred and seventy-five cubic feet, or thirteen hundred gallons of oxygen per day, is being put up, on the Champ de Mars, in a laboratory adjoining the lecture-room appropriated to the Abbé, where it will be employed, among other things, in furnishing gas for the illumination of that hall. The lamp employed in this case will be that of M. Carlevaris, of Genoa, in which a combined jet of illuminating gas, or of naptha vapor, with oxygen, is directed upon plates of magnesia and chloride of magnesium united.

Another process may well be recalled in connection with these two, although it has, we think, been mentioned before. It consists in exposing subchloride of copper (Cu_2Cl) to the air, until it absorbs oxygen enough to convert it into the oxychloride (Cu Cl Cu O), and again returning this to its original state, by the application of heat. This process, devised by M. Mallet, was lately introduced to the French Academy by M. Dumas. We observe, in the notices of patents, that protection for this process is in course of being secured by its inventor, in England. Many years ago a plan analogous to the second of those above, in which protoxide of barium (Ba O) was first oxidized by air and heat, and then reduced by steam, was published and commended, but seems to have passed into oblivion without any (at least recorded) trial of its merits.

Arsenuretted hydrogen may be distinguished or separated from antimoniuretted hydrogen, by passing the suspected or mixed gas through a tube containing solid pieces of caustic potash. The antimony, if present, will be here deposited as a brilliant metallic coating, while the arsenuretted hydrogen will escape without decomposition. For further particulars see *Chemical News*, page 150.

Hypochloride of magnesia, for bleaching, possesses the following advantages over the corresponding salt of lime, when delicate tissues are to be treated: 1st. It decomposes more easily. 2d. The liberated magnesia has no action on the tissues. It is best prepared by decomposing sulphate of magnesia with hypochloride of lime. If manganese is present, the liquid loses its bleaching power, and acquires a red color. (See as above.)

Extract of meat.—Some remarkable facts, not generally appreciated, seem to be developed by the evidence brought before the sub-committee on Food, of the Society of Arts. Thus it would appear that extract of meat, even that prepared by Liebig's process, is less important as a nutritious body than as a means, like tea and coffee, of preventing waste in the tissues. The statement was made that "a teaspoonful of extract did not contain as much nutriment as a mouthful of meat." "But one-fifth to one-eighth of the solid constituents of meat pass into the extract." The rest of the evidence, so far published, is to the same effect. The process of Professor Gamgee for preserving meat, in which the pickling process is conducted (it is said without pain) upon the living, or rather dying animal, is to be thoroughly tested before the same committee. See, for full account of the above, *Chemical News*, page 161.

Preservation of meat, by a process which bears much analogy to the Burnetizing of timber, is exhibited at the Paris "Exposition," and is highly commended by the Abbé Moigno. It is devised by M. François Cerio, of Turin, and is conducted as follows: The meat to be treated is, as soon as possible after killing, placed in a closed vessel, from which the air is exhausted by a pump. After this the brine is admitted by an appropriate tube, and allowed to remain in contact with the meat for a few minutes, which will suffice for a thorough action. The meat is then removed, and packed, or allowed to dry, as occasion may require.

Artificial meerschaum, as we learn from M. Holdman, in the *Chemical News*, is prepared by mixing one hundred parts of silicate of soda at 35° (we presume a solution at 35° Baumé) with sixty parts of carbonate of magnesia and eighty parts of native meerschaum, or of pure alumina. This mixture is carefully pulverized and finely sifted, boiled with water and put in porous moulds.

Plaster of Paris, when mixed with alum, forms an excellent cement for use in the laboratory. This recipe is an old one, but good enough to bear recalling to mind.

Organic matter in water, its test.—Professor Frankland, in a lecture lately delivered before the Royal Institution, shows that permanganate of potash is anything but a satisfactory test of the amount of organic matter present in water. Thus, of seven organic bodies tried, the actual amount in each case being three grains, this test indicated, respectively, ·082, ·051, ·114, ·634, ·064, ·074 and ·074 grains, or, in the best case, but about one-fifth of the true amount.

A lightning flash struck the light-house at Fecamp, creating great havoc, though the edifice was provided with a rod, carried into a cistern, *thickly lined with Portland cement.* The atmospheric electricity of that locality evidently objects to entering anything like a Leyden jar, after the same has been fully charged by its previous action.

Alcohol from the Jerusalem artichoke.—M. Dubrunfraut finds that the juice of these roots, properly fermented, yields eight to nine per cent. of concentrated alcohol.

Ingots of indium, at the Paris Exhibition, weighing about fifteen hundred grains, and valued at about $3600, are exhibited by M. Richter, of Friburg, one of the companion discoverers of this element.

Electric instruments of registration.—We have received from Messrs. Edmonds and Hamblet, of Boston, a descriptive catalogue of various instruments, a knowledge as to the existence of which may be useful to some of our readers. The first of these is the **electric watch clock,** which records, with great precision as to time, the performance of various duties, such as those of the night watchman in a large establishment, those of a boiler tender in trying his gauge-cocks, and the like. It may be connected with every part of a large establishment, without the least risk of becoming inefficient through change of temperature, or stretching of wires, as with the merely mechanical instruments of a like character. The battery being only intermittently in action, never requires attention more than once in six months. We next find the **electric pendulum gauge,** which records at any distance, either at stated times or at any moment, on application, the condition of a gas-holder, reservoir, or the like. Without attempting to explain the details of this apparatus, which, without figures, it would be almost impossible to accomplish, we may say, generally, that by depressing a key, either by the hand at *any* time, or by clock-work mechanism at *stated* times, an electric current is initiated, which at the distant reservoir liberates and keeps

in motion a pendulum, with which is connected machinery whose range of continued motion is limited by the position of the gas-holder, the level of the water in a reservoir, or the like. The pendulum, therefore, makes more or fewer vibrations, according to the state of these recipients, and as each vibration makes and breaks circuit in the original current, this easily operates a recording apparatus at the other end of the line. Again, we find a sytem for **plural time dials,** which possesses many points of originality and merit, and lastly, a **magneto electric alphabetic telegraph,** which requires no battery, the electric force being obtained from a magneto-electric machine, worked by the operator when he is using the instrument.

The Brooks Insulator.—In the *Telegrapher* of April 15th we find, in full, a report made by Dr. C. M. Cresson to Wm. J. Phillips, Superintendent of Police and Fire Alarm Telegraphs, on various insulators submitted for examination. We have only space here for the general practical result, which may be well expressed by the following extract:

"Repeated trials made upon the whole of the samples, side by side, exposed to a continuous shower of water, gave results as follows (the comparison being made in the consumption of zinc derived from actual trials, in the production of equal deflections of the astatic needle by battery power):

No. 1 (Wades'),	over	35
No. 2 (Lefferts'),	"	30
No. 3 (glass and bracket),	"	80
No. 4 (Brooks'),	less than	1
No. 5 (rubber-covered book),	"	28
No. 6 (English),	"	16

"From this it would appear that the wooden covering of Nos. 1 and 2, actually took away from the insulating powers of the inclosed glass, which glass was very similar in form to No. 3.

"A close examination of Nos. 3, 5 and 6, revealed a surface full of minute pores or cracks, capable of absorbing water and of retaining it.

"The Brooks Insulator alone remained intact during all conditions, and it was assumed for the sake of comparison, that the deflection was 1°, although the motion of the needle was too small to be read off on the scale; whilst the insertion in the circuit of No. 1 caused a deflection of over 45°. The success of the Brooks Insulator was entirely due to the use of paraffine, with which the glass and sulphur (in the different specimens presented for trial) were completely saturated,

filling up all the minute pores and crevices, and rendering the surface of the insulating medium repellant of water.

* * * * * * * *

"The Brooks Insulator, constructed with an iron case with the wire hook secured into it by glass or sulphur, and the whole thoroughly saturated with paraffine and provided with a shedding collar of porous earthenware, likewise saturated with paraffine, seems to me to combine all of the requisites for complete success."

OUR NEW YORK CORRESPONDENCE.

NEW YORK, *May* 27, 1867.

DESPITE the dullness that hangs over this great city, projects of considerable engineering interest are being discussed, which, if carried out, will make New York of more metropolitan greatness than ever, and a more worthy stopping place between the Continent and the Oriental East, when the boasted Pacific Railroad is completed. First and foremost is the problem of rapid transit from the suburbs to the heart of the city, and for this purpose numerous plans are proposed, some utterly absurd, some problematical and some really practical—all, however, costly from necessity. The last Legislature, for some "wise purpose," refused to grant a franchise for any scheme, but graciously passed a bill to allow one applicant to build a half mile of experimental line, and if successful, to encircle the city with it. This is the West Side and Yonkers Elevated Railway Company, who expect, by middle of summer, to show what they can do. However, for the present, we will drop this interesting question until another writing, when I will endeavor to lay all the schemes before you, and devote my space to them alone. I hardly know whether the East River Bridge is a fixed fact or not, for the holders of the franchise are interested in the long established ferry companies, the President of the Bridge Company being the *counsel* for this antagonistic interest. However, be that as it may, a form of organization has been gone through, and the necessary committees appointed, with John A. Roebling as Chief Engineer. Surveys have been ordered, to determine the best line of crossing, upon the completion of which subscribers to the stock may be advertised for. The charter gives unlimited time to finish the work, and a generous allotment for the commencement of

it. As far as I can learn, the plan in general will be of the suspension class, with three sets of cables, carrying a platform properly stiffened, to accommodate the crossing of at least two hundred and fifty thousand persons daily. To do this, the platform would be broken up for two carriage-ways, thirteen feet each; two car-ways, sixteen feet each; and a foot walk, seven feet wide on either side. This would require four cables and in all about seventy-five feet of width. The height of platform above high water, at centre of bridge, would be about one hundred and thirty feet, grading down each way to only a hundred feet at the abutments. The cars for crossing are intended to be large and roomy, and to be operated by stationary engines and an endless belt or rope. Three minutes is the time estimated to be required from Main Street, Brooklyn, to City Hall, New York. It is expected that six millions of dollars, at farthest, will complete the work. Without going into a more critical examination of this plan, it would seem that the steep grade adopted would concentrate all the tall-masted shipping in the centre of the river, and seriously interfere with navigation. An interesting experiment upon block-tin water pipes came off in this city a few days ago. A great many efforts have been made to substitute some kind of piping for the injurious lead pipe, so long employed, but none have been crowned with such complete success as that made by drawing from tin encased with lead. The process is as follows: A solid cylinder of tin, weighing, say, fifteen pounds, is bored of a certain diameter. It is then placed in a larger cylinder, having poured around it melted lead. A powerful hydraulic press forces it through a gauge, (just as in wire drawing, a steel rod forming, as it were, the core. The line of contact of the lead and tin is clearly defined, and the pipe is a very perfect one. The following are the results of some of the experiments: An ordinary leaden pipe, one inch interior diameter, and weighing four pounds eleven ounces per foot, burst at pressure of one thousand pounds on gauge. A tin-coated pipe, of like capacity, but weighing only two pounds six ounces per foot, required eleven hundred and fifty pounds to burst it. A three-quarter inch lead pipe, weighing three and eight-tenths of a pound per foot, required a pressure of twelve hundred pounds before bursting. A tin-coated pipe of the same calibre brought the dynamometer up twelve hundred and seventy-five before bursting; this last weighed only one and twelve-hundredths pounds per foot. About the same ratio was kept up with other sizes experimented upon, showing a great saving in weight, with a com-

mensurate gain in strength. As no injurious chemical action takes place between water and the tin lining, we must hail this improvement in water-pipes as a long needed and beneficial one, which, when once well known, will meet with unbounded success.

The Hudson River Railroad Company is erecting upon the site of St. John's Park a large fire-proof freight depot, in three stories. The building will cover an area of little over four acres, being four hundred and thirty-eight feet on Hudson and Vesey, and four hundred and five feet on Beach and Laight Streets. The area will be broken up by five double-track pitways, to accommodate the various freight lines converging upon this railroad. The lower floor will be, of course, devoted entirely to depot purposes, while the upper ones will be arranged for required offices and storage rooms. Steam elevators will be located at intervals, to do all the hoisting for the warehouses. There will be a central area of about one hundred by one hundred and forty feet left by the warehouses, which run back but one hundred and fifty feet from each street. The present intention is to cover this area with glass and iron, but this, like a great many other projected features, is entirely at the mercy of the eccentric presiding genius of the company, and it will be a very difficult matter to tell how the building will be, until completed. It has been decided, however, to make the elevated platforms russ pavements.

In my next I will send diagrams, &c., illustrating one of the most marked improvements in locomotive boilers, for the more perfect consumption of gases. I am awaiting the results of some experiments, or you should have it at this writing. A. P. B.

Encouraging views of American affairs are not often announced from the other side of the Atlantic; but in the *London Economist*, of a late date, we find an article of which the following extract is a fair sample. "The United States have still the best possible land, the best mines, the best things above ground, the best things under ground, and an educated Anglo-Saxon race to make use of all of them. Such means and materials for production, and such skill in making, the world has never seen together. In consequence, wealth is created faster than ever before, and the government can tax it much more readily."

Civil and Mechanical Engineering.

FORMULAS AND TABLES FOR THE SHAFTING OF MILLS AND FACTORIES.

By James B. Francis, Civil Engineer.

The following investigation was undertaken at the request of General John C. Palfrey, the Agent of the Merrimack Manufacturing Company, of Lowell, Massachusetts, for the purpose of determining the relative fitness of wrought iron and steel for the shafting of a cotton factory now erecting by that company.

Samples of steel, all of American manufacture, were obtained from different makers, and, together with several samples of iron, were subjected to experiment.

The constant expressing the resistance of cylindrical bars to torsion, I deduce from Navier's formula,*

$$T = \frac{16\ W\ R}{\pi\ d^3}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1.)$$

in which,

T = a constant for the same material.

W = the weight, in pounds, which, if applied at the distance R, in inches, from the axis, will just fracture the bar.

π = the ratio of the circumference of a circle to its diameter.

d = the diameter, in inches, of the bar at the place of fracture.

The bars subjected to torsion, were finished in the form of the following diagram; the ends being two inches square, and the middle turned down to a diameter of $\frac{3}{4}$ inch, in order to insure the fracture taking place in that part of the bar.

The weight producing the torsion was applied at the end of a lever, of the effective length of 35·975 inches, fitted to the square boss at one end of the bar. The tendency of the bar to revolve

* Resumé des Leçons sur l'application de la mécanique.

under the action of the weight, was controlled by a worm-wheel about fifteen inches in diameter and one hundred and thirty-eight teeth, fitted to the square boss at the other end of the bar. This wheel could be moved through any arc by means of a worm. As the bar became twisted by the torsional strain, the worm-wheel was moved through an arc sufficient to bring the lever to an horizontal position.

A graduated circle on one face of the worm-wheel, furnished the means of measuring the arc of torsion.

The effective weight of the lever and scale at 35·975 inches from the axis, where the scale was hung on a knife edge, was 48·5 pounds, and was the least effective weight which could be applied to produce torsion.

EXPERIMENTS ON TORSION.

DESCRIPTION OF THE BAR.	Mean diameter of the reduced part of the bar, in inches.	Arc of torsion just before fracture.	Weight producing fracture, in pounds.	Mean temperature of the air.	Value of **T**
English refined wrought iron, from a bar two inches in diameter, marked A, 13	0·750	416·8°	113·17	58·8°	49,148
Same, marked 13	0·750	596·0°	125·69	66·0°	54,585
Wrought iron, from the Pembroke Iron Works, Maine, marked 14	0·753	641·3°	143·72	62·3°	61,673
Decarbonized steel, from the Farist Steel Company, Windsor Locks, Conn., from a bar two inches square, marked B, 6	0·752	390·5°	192·48	70·2°	82,926
Spindle steel, from the same, from a bar two inches square, marked A, 5	0·750	284·3°	235·17	68·3°	102,131
Steel, from the Nashua Iron Co., Nashua, N. H., from a bar two inches square, marked 2	0·751	611·3°	198·73	65·5°	85,961
Same, marked *d*, 2	0·752	557·0°	203·23	63·7°	87,557
Steel, from same, from 1¼ inch octagonal bar, marked 4	0·752	475·0°	221·0	67·5°	95,213
Same, marked 3	0·751	508·3°	217·25	61·2°	93,972
Steel, from the works of Hussey, Wells & Co., Pittsburgh, from a bar two inches square, marked E, 1	0·751	308·0°	202·66	63·6°	87,661
Same, marked 1	0·748	297·3°	196·50	68·0°	86,023
Bessemer steel, from the works of Messrs. Winslow & Griswold, Troy, N. Y., from a bar two inches square, marked 16	0·748	215·5°	181·97	66·0°	79,662
Same, marked 16 x	0·748	268·5°	174·50	67·0°	76,392

The experiments on deflection were made on round bars turned to a diameter of about one inch. The distance between the points of support was forty-eight inches. Observations were made of the deflections produced by a weight of one hundred and fifty pounds suspended at the middle point between the supports. This weight was not sufficient to cause any sensible set in the bar after the weight was removed; and no sensible increase in the deflection was produced by allowing the weight to remain suspended on the bar for several days.

The constant E for deflection, has been computed by Navier's formula,*

$$s = \frac{l^3 W}{6 \pi d^4 E}, \quad \ldots \ldots \ldots \quad (2,)$$

in which

l = the distance between the points of support, in inches.

W = the weight at the middle point between the supports, in pounds.

π = the ratio of the circumference of a circle to its diameter.

d = the diameter of the bar, in inches.

s = the deflection at the middle point between the supports, in inches.

EXPERIMENTS ON DEFLECTION.

DESCRIPTION OF THE BAR.	Diameter of bar at the middle, in inches.	Deflection, in inches.	Mean temperature of the air.	Value of E
Spindle steel, from the Farist Steel Co., Windsor Locks, Conn., from a bar 1 1-16 inches in diameter, marked A, 7	0·995	0·2330	48·0°	3,853,590
Same, marked A x 7	0·977	0·2315	53·8°	3,847,530
Decarbonized steel, extra, from the Farist Steel Co., from a bar 1 1-16 inches in diameter, marked A A x	0·993	0·2310	53·0°	3,918,360
Same, marked A A 8	0·995	0·2327	53·7°	3,858,557
Decarbonized steel, from the Farist Steel Co., from a bar 1 1-16 inches in diameter, marked 9 x B	0·992	0·2330	54·2°	3,900,420
Same, marked 9 B	0·995	0·2307	53·3°	3,892,008
Steel, from the works of Hussey, Wells & Co., Pittsburgh, from a bar 1 1-16 inches in diameter, marked 15	0·998	0·2337	52·2°	3,796,060
Same, marked 15 x	0·996	0·2337	49·8°	3,826,641
Bessemer steel, from the works of Messrs. Winslow & Griswold, Troy, New York, from a bar 1 1-16 inches in diameter, marked 17 x	1·000	0·2330	49·4°	3,777,095
Same, marked 17	1·000	0·2315	52·0°	3,801,566

* See the number of this Journal for February, 1862.

Several specimens of the steel have been tested for tensile strength, at the works of the South Boston Iron Company, by Mr. F. Alger, in the apparatus designed by Major W. Wade, for testing metals for cannon, a description of which may be found in *Reports of Experiments on the Strength and other Properties of Metals for Cannon*, published in 1854, by authority of the Secretary of War.

EXPERIMENTS ON TENSILE STRENGTH.

DESCRIPTION OF THE SPECIMEN.	Diameter at the place of fracture, in inches.	Weight producing fracture, in pounds.	Tensile strength per square inch in pounds.	Specific Gravity.
Spindle steel, from the Farist Steel Co., Windsor Locks, Conn., marked A 10 A 1	0·597	40,800	145,754	7·8401
Same, marked A 10 A 2	0·598	39,500	140,639	7·8287
Decarbonized steel, from the same, marked B 11 B 1	0·596	34,500	123,662	7·8583
Same, marked B 11 B 2	0·597	35,200	125,750	7·8514
Decarbonized steel, extra, from the same, marked A A x 1	0·600	30,500	107,862	7·8417
Same, marked A A x 2	0·600	30,900	109·271	7·8579
Same, marked A A x; ends upset in order to form the specimen	0·600	30,800	108,901	7·8484
Same as next preceding specimen, marked A A x 2	0·600	29,700	105,053	7·8534
Steel, from the works of Hussey, Wells & Co., Pittsburgh, marked c 12, 1	0·594	40,400	145,790	7·8530
Same, marked c 12, 2	0·594	40,200	145,070	7·8496

I find on record many experiments on the fracture of iron and steel by torsion, from which I deduce the following values of T; using the above formula for cylindrical bars, and Navier's formula,

$$T = \frac{3\sqrt{2}\,W\,R}{b^3}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3,)$$

for square bars, in which b = the side of the square in inches, and W and R the weight in pounds, producing fracture, and the distance from the axis in inches, at which it is applied.

EXPERIMENTS BY RENNIE, given in the *Philosophical Transactions of the Royal Society, for* 1818.

Bar of English wrought iron, 0·25 inch square, ...T = 65,982
Bar of Swedish " 0·25 " .....T = 61,909
Bar of shear steel, 0 25 " .....T = 111,191
Average of 3 bars of iron cast horizontally, 0·25 in. sq., T = 64,776

EXPERIMENTS given in the fifth edition of *Haswell's Engineers' and Mechanics' Pocket Book.*

Bar of Ulster Iron Co.'s wrought iron, one inch diameter, T = 87,090
Bar of Swedish " " " T = 93,965

EXPERIMENTS made at the Royal Gun Factories, Woolwich, England, on many varieties of cast iron. *Parliamentary Document ordered to be printed July* 30, 1858.

Experiments are given on fifty-one varieties of British cast iron, besides several varieties from other countries. I select the experiments on four varieties of British iron, viz: the strongest, two of medium strength, and the weakest; each result being deduced from a mean of several experiments on bars about 1·8 inch in diameter.

From West Hallam Iron Works, Ilkeston ..... T = 38,217
" Netherton Iron Works ..... T = 34,490
" Butterley " ..... T = 33,949
" Hæmatite Iron Company ..... T = 22,132

EXPERIMENTS made at the Fort Pitt Foundry, in 1846, on bars of different forms and dimensions, of common foundry iron, given in *Reports of Experiments*, &c., above cited.

Bar about one inch square ..... T = 36,846
" 1·415 inch square ..... T = 34,443
" about 1·749 inch square ..... T = 42,821
" 1·135 inch in diameter ..... T = 37,445
" 1·595 " " ..... T = 42,047
" 1·955 " " ..... T = 38,851

EXPERIMENTS made at the West Point Foundry, in 1851, on Greenwood iron of different grades, mixtures and fusions, given in *Reports of Experiments*, &c., above cited.

Mean deduced from eighteen experiments on bars about 1·9 inches diameter ..... T = 44,957

The value of E, for wrought iron, I have previously deduced from English experiments, and tested by a single experiment on a shaft two inches in diameter and about 180 inches between bearings.* From these experiments I find ..... E = 3,492,539

There being such great irregularities in the values of T, it will not be safe, in practice, to take a mean value, but one near the lowest value.

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* See the number of this Journal for February, 1862.

The values for wrought iron vary from 49,148 to 93,965. For safety, I take for wrought iron ..... T = 50,000
The values for steel vary from 76,392 to 111,191. For safety, I take for steel ..... T = 80,000
The values for cast iron vary from 22,132 to 64,776. For safety, I take for cast iron ..... T = 30,000
I also take for wrought iron ..... E = 3,500,000
And for untempered steel ..... E = 3,800,000

Shafts for transmitting power, are subject to two forces, viz: transverse strain and torsion. In shafts of wrought iron or steel, in which the bearings are not very near to each other, a transverse strain, too small to cause fracture, will produce sensible deflection; if this is too great, it will produce sensible irregularities in the motion, and tend towards the rapid destruction of the shaft and its bearings. This limits the distance between the bearings, as the weight of the shaft itself will produce an inadmissible amount of deflection whenever this distance exceeds a certain amount, which varies with the material and diameter of the shaft.

The deflection of a cylindrical shaft from its own weight, supported at each end, but disconnected from other shafts, is given by the formula (4), which is deduced from Navier's formula for the deflection of a cylindrical bar. *See Journal of the Franklin Institute for February*, 1862.

$$\partial = 0{\cdot}007318 \frac{l^4}{d^2 E}, \quad . \quad . \quad . \quad . \quad . \quad (4.)$$

If the several parts are so connected as to be equivalent to one continuous shaft, it will correspond to the case of a beam fixed at both ends, for which case Barlow* gives ∂ equal to two-thirds of its value in the case of a beam supported at both ends, given by formula (4). Navier†, taking into account the effect of the deflection in the adjacent divisions, finds ∂ equal to one-fourth of its value by formula (4). In order to decide which of these eminent authorities to follow, I have appealed to experiment.

Experiment 1. A bar of wrought iron purchased as "English refined," 12 feet 2¾ inches long, 0·367 inch deep, 1·535 inch wide, was supported at four equidistant points, four feet apart. When loaded at the middle points of each division with fifty-two pounds, the deflection in the middle division was 0·069 inch, and the

* Report of the third meeting of the British Association for the Advancement of Science.

† Résume des leçons sur l'application de la mécanique.

mean deflection in the other two divisions was 0·371 inch. The weight on the middle division was then increased until the deflection was alike, viz: 0·281 inch in each division; the weight being 82·84 pounds in the middle division, and 52·00 pounds in each of the other divisions. Four feet was then cut off of each end of the bar, when the deflection, with 82·84 pounds on the middle division, was 1·102 inch.

Experiment 2. A bar of iron of the same quality and length as in experiment 1, 0·551 inch square, was laid on the same supports. When loaded at the middle points of each division with fifty-two pounds, the deflection in the middle division was 0·058 inch, and the mean deflection in the other two divisions was 0·314 inch. The weight on the middle division was then increased until the deflection was 0·241 inch in each division; the weight being 82·84 pounds in the middle division, and 52·00 pounds in each of the other divisions. Four feet was then cut off of each end of the bar, when the deflection, with 82·84 pounds on the middle division, was 0·984 inch.

In the case in which the deflections were alike in the three divisions, the middle division corresponds to the case of a continuous shaft supported by numerous equidistant bearings, and the case where the bar was reduced in length, corresponds to that in formula (4). Comparing the deflections in the two cases in the above experiments, we find by experiment 1, that the ratio of the deflection of the shaft, simply supported at each end, to that of the continuous shaft, is as 1 to 0·255. In experiment 2, the corresponding ratio is as 1 to 0·245; the mean of the two experiments giving a ratio of 1 to 0·25,* which agrees with Navier, and we must adopt for the deflection of a continuous shaft, from its own weight, the formula

$$\delta = \tfrac{1}{4} \times 0{\cdot}007318 \frac{l^4}{d^2 \mathrm{E}}, \quad . \quad . \quad . \quad . \quad (5.)$$

The greatest admissible value of δ in proportion to the length, must be determined by experience. Tredgold assumes that for cast iron, it might be 0·01 inch for each foot in length, or $\frac{1}{120}$ part of the

* These experiments indicate the effect of connecting the chords of truss bridges over the piers. Assuming that in a bridge of not less than three equal spans, the top and bottom chords have equal resisting powers, and the whole length of the bridge is uniformly loaded, if the chords are continuous throughout the whole length of the bridge, the deflection of any span, except the end spans, will be one quarter of the amount that it would be if the chords were disconnected at the piers.

length, *whatever may be the diameter;* but the transverse strain to produce this deflection, is a greater fraction of the transverse strain that will produce fracture in a large shaft than in a small one. The maximum strains of extension and compression in a shaft, for the same deflection, are in proportion to the diameter, while the deflection itself, from the weight of the shaft, is inversely as the square of the diameter; consequently, the deflection to produce the same maximum strains, must be inversely as the diameter.

Adopting this principle and the assumption that a shaft of wrought iron or untempered steel two inches in diameter, may deflect from its own weight, 0·01 inch per foot in length between the bearings, we may determine the greatest admissible distances between the bearings of shafts of other diameters, as follows:

The greatest admissible deflection for any diameter d, is

$$\delta = \frac{2l}{1200d} = 0{\cdot}00167\,\frac{l}{d}, \quad . \quad . \quad . \quad . \quad . \quad (6.)$$

Substituting this value of δ in (5) and reducing, we have

$$l = \sqrt[3]{0{\cdot}9128\,d\,\mathrm{E}}, \quad . \quad . \quad . \quad . \quad . \quad (7.)$$

TABLE *of the greatest admissible distances between the bearings of continuous shafts, subject to no transverse strain except from their own weights; computed by formula* (7).

DIAMETER OF SHAFT, IN INCHES.	Distance between bearings, in feet.	
	If of wrought iron	If of steel
1	12·27	12·61
2	15·46	15·89
3	17·70	18·19
4	19·48	20·02
5	20·99	21·57
6	22·30	22·92
7	23·48	24·13
8	24·55	25·23
9	25·53	26·24
10	26·44	27·18
11	27·30	28·05
12	28·10	28·88

In practice, long shafts are scarcely ever entirely free from transverse strains; however, in the parts of long lines which have no pulleys or gears, with the couplings near the bearings, the interval

between the bearings may approach the distances given in the preceding table. Near the extremities of a line, the distances between the bearings should be less than are given in the table. The last space should not exceed sixty per cent. of the distance there given, the deflection in that space being much greater than in other parts of the line. In shafts moving with high velocities, it will usually be necessary to shorten the distances between the bearings, as given in the table, in order to obtain sufficient bearing surface to prevent heating.

In factories and workshops, power is usually taken off from the lines of shafting, at many points, by pulleys and belts, by means of which the machinery is operated. When the machines to be driven are below the shaft, there is a transverse strain on the shaft, due to the weight of the pulley and tension of the belt, which is in addition to the transverse strain due to the weight of the shaft itself. Sometimes the power is taken off horizontally on one side, in which case the tension of the belt produces a horizontal transverse strain; and the weight of the pulley acts with the weight of the shaft, to produce a vertical transverse strain. Frequently the machinery to be driven is placed above the floor to which the shaft is hung in the story below; in this case the transverse strain produced by the tension of the belt is in the opposite direction to that produced by the weight of the pulley and shaft. Sometimes power is taken off in all these directions, from the part of a shaft between two adjacent bearings. To transmit the same power, the necessary tension of a belt diminishes in proportion to its velocity; consequently, with pulleys of the same diameter, the transverse strain will diminish in the same ratio as the velocity of the shaft increases. In cotton and woollen factories with wooden floors, the bearings are usually hung on the beams, which are usually about eight feet apart; and a minimum size of shafting is adopted for the different classes of machinery which has been determined by experience as the least that will withstand the transverse strain. This minimum is adopted independently of the size required to withstand the torsional strain due to the power transmitted; if this requires a larger diameter than the minimum, the larger diameter is, of course, adopted. In some of the large cotton factories in this neighborhood, in which the bearings are about eight feet apart, a minimum diameter of $1\frac{7}{8}$ inch was formerly adopted for the lines of shafting driving looms. In some mills this is still retained, in others $2\frac{1}{8}$ inches and $2\frac{3}{16}$ inches have been substituted.

In the same mills, the minimum size of shafts driving spinning machinery, is from $2\frac{1}{8}$ to $2\frac{1}{16}$ inches. In very long lines of small shafting, fly-wheels are put on at intervals, to diminish the vibratory action due to the irregularities in the torsional strain.

We can deduce from formula (1) the *breaking power*, or, in other words, the power which, being transmitted by a shaft, will produce a torsional strain upon it equal to its total resistance to that force.

Put p = the breaking power, in horse-powers of 33,000 foot-pounds,

N = the number of revolutions of the shaft per minute.

$$p = \frac{2\pi \text{R N W}}{12 \times 33000},$$

from which we deduce,

$$\text{W R} = \frac{12 \times 33000\, p}{2\pi \text{N}}.$$

Substituting this value in (1), we find,

$$p = \frac{\pi^2 \text{N} d^3 \text{T}}{8 \times 33000 \times 12} = 0{\cdot}000003115 \text{N} d^3 \text{T}, \quad . \quad . \quad (8.)$$

Substituting the values of T, adopted above for iron and steel, we have

For wrought iron, $p = 0{\cdot}1558 \text{N} d^3$, ... (9.)

" steel, $p = 0{\cdot}2492 \text{N} d^3$, ... (10.)

" cast iron, $p = 0{\cdot}0935 \text{N} d^3$, ... (11.)

A formula for the wrought iron shafts of prime movers and other other shafts of the same material, subject to the action of gears, which I have adopted in numerous cases in practice during the last twenty years, and found to give an ample margin of strength, is

$$d = \sqrt[3]{\frac{100 \text{P}}{\text{N}}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12,)$$

in which P = the power transmitted, and from which we deduce

$$\text{P} = 0{\cdot}01 \text{N} d^3, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13.)$$

For simply transmitting power, the formula I have used is

$$d = \sqrt[3]{\frac{50 \text{P}}{\text{N}}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14,)$$

from which we deduce $\text{P} = 0{\cdot}02 \text{N} d^3$, ... (15.)

Comparing formulas (9) with (12) and (13), and also with (14) and (15), it will be seen that the formulas (12) and (13), used for shafts for prime movers, give a strength 15·58 times the breaking power; and the formulas (14) and (15), for shafts simply transmitting power, give a strength 7·79 times the breaking power.

In applying the rules for the strength of materials to constructions in which there is no movement, it is usual to make the computed strength from three to five times the breaking strain. Bodies in rapid motion, however, usually require a greater margin of strength, in order to provide for the tendency to vibration. In cases where shafting for simply transmitting power, is very accurately finished and firmly supported by bearings at short intervals, an excess of strength two-thirds of that given by formulas (14), (19) and (23) will undoubtedly suffice. In ordinary cases, however, the strength given by these formulas should be adopted.

It must be understood that the shafts to which formulas (12) and (13) are applied, are supported by bearings sufficiently near to each other to guard against the transverse strain caused by the prime mover or gear.

To find formulas for steel shafts of the same strength as those for wrought iron, we have for prime movers $p = 15{\cdot}58\,\text{P}$; substituting this value of p in (10), we have

$$\text{P} = 0{\cdot}016\,\text{N}\,d^3, \quad . \quad . \quad . \quad . \quad . \quad . \quad (16,)$$

from which we deduce

$$d = \sqrt[3]{\frac{62{\cdot}5\,\text{P}}{\text{N}}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (17.)$$

Similarly, we find for steel shafts for simply transmitting power,

$$\text{P} = 0{\cdot}032\,\text{N}\,d^3, \quad . \quad . \quad . \quad . \quad . \quad . \quad (18,)$$

and

$$d = \sqrt[3]{\frac{31{\cdot}25\,\text{P}}{\text{N}}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (19.)$$

Similarly for cast iron, we find for prime movers,

$$\text{P} = 0{\cdot}006\,\text{N}\,d^3, \quad . \quad . \quad . \quad . \quad . \quad . \quad (20.)$$

$$d = \sqrt[3]{\frac{167\,\text{P}}{\text{N}}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (21.)$$

For simply transmitting power,

$$\text{P} = 0{\cdot}012\,\text{N}\,d^3, \quad . \quad . \quad . \quad . \quad . \quad . \quad (22,)$$

$$d = \sqrt[3]{\frac{83\,\text{P}}{\text{N}}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (23.)$$

The following table gives the power which can be safely carried by shafts making one hundred revolutions per minute. The power which can be carried by the same shafts at any other velocity, may be found by the following simple rule:

Multiply the power given in the table, by the number of revolutions made by the shaft per minute; divide the product by one hundred; the quotient will be the power which can be safely carried.

DIAMETER IN INCHES.	Horse-power which can be safely carried by shafts for prime movers and gears, well supported by bearings, and making 100 revolutions per minute; if of			Horse-power which can be safely transmitted by shafts making 100 revolutions per minute, in which the transverse strain, if any, need not be considered; if of		
	Wrought iron, computed by formula (13)	Steel, computed by formula (16)	Cast Iron, computed by formula (20)	Wrought Iron, computed by formula (15)	Steel, computed by formula (18)	Cast Iron, computed by formula (22)
1·00	1·60	1·60	0·60	2·00	3·20	1·20
1·25	1·95	3·12	1·17	3·90	6·24	2·34
1·50	3·37	5·39	2·03	6·74	10·78	4·06
1·75	5·36	8·58	3·22	10·72	17·16	6·44
2·00	8·00	12·80	4·80	16·00	25·60	9·60
2·25	11·39	18·22	6·83	22·78	36·44	13·66
2·50	15·62	24·99	9·37	31·24	49·98	18·74
2·75	20·80	33·28	12·48	41·60	66·56	24·96
3·00	27·00	43·20	16·20	54·00	86·40	32·40
3·25	34·33	54·93	20·60	68·66	109·86	41·20
3·50	42·87	68·59	25·72	85·74	137·18	51.44
3·75	52·73	84·37	31·64	105·46	168·74	63·28
4·00	64·00	102·40	38·40	128·00	204.80	76·80
4·25	76·77	122·83	46·06	153·54	245·66	92·12
4·50	91·12	145·79	54·67	182·24	291·58	109·34
4·75	107·17	171·47	64·30	214·34	342·94	128·60
5·00	125·00	200·00	75·00	250·00	400·00	150·00
5·25	144·70	231·52	86·82	289·40	463·04	173·64
5·50	166·37	266·19	99·82	332.74	532·38	199·64
5·75	190·11	304·18	114·06	380·22	608·36	228·12
6·00	216·00	345·60	129·60	432·00	691·20	259·20
6·25	244·14	390·62	146·49	488·28	781·24	292·98
6·50	274·62	439·39	164·78	549·24	878·78	329·56
6·75	307·55	492·08	184·53	615·10	984·16	369·06
7·00	343·00	548·80	205·80	686·00	1097·60	411·60
7·25	381·08	609·73	228·65	762·16	1219·46	457·30
7·50	421·87	674·99	253·13	843·74	1349·98	506·26
7·75	465·48	744·77	279·29	930·96	1489·54	558·58
8·00	512·00	819·20	307·20	1024·00	1638·40	614·40
8·25	561·52	898·43	336·91	1123·04	1796·86	673·82
8·50	614·12	982·59	368·47	1228·24	1965·18	736·94
8·75	669·92	1071·87	401·95	1339·84	2143·74	803·90
9.00	729·00	1166·40	437·40	1458·00	2332·80	874·80
9·25	791·45	1266·32	474·87	1582·90	2532·64	949·74
9·50	857·37	1371·79	514·43	1714·74	2743·58	1028·86
9·75	926·86	1482·98	556·12	1853·72	2965·96	1112·24
10.00	1000·00	1600·00	600·00	2000·00	3200·00	1200·00

Comparing formulas (14) and (19), it will be seen that the diameters of shafts of wrought iron and steel, to transmit the same power, are in the ratio of the cube root of 50 to the cube root of 31·25, or as 1 to 0·855. The weights of the shafts will be as the squares of the diameters, or as 1 to 0·731. The power required to overcome the friction of the shafts in their bearings, assuming that the co-efficient of friction is the same for wrought iron and steel, will be as the products of the weights into the velocities of the rubbing surfaces. The number of revolutions in a given time being the same in both, the velocities of the rubbing surfaces will be as the diameters; and the weights will be as the squares of the diameters; the power required to overcome the friction will therefore be as the cubes of the diameters, or as 1 to 0·625. That is to say, the power which must be expended to overcome the friction of a steel shaft is five-eighths of that required to overcome the friction of a wrought iron shaft of equal strength.

The superiority of steel to resist transversal strain is much less than to resist torsional strain. The relative diameters of wrought iron and steel shafts, to resist equal transverse strains, exclusive of their own weights, are inversely as the fourth roots of the respective values of E, or as $\left(\frac{1}{3500000}\right)^{\frac{1}{4}}$ to $\left(\frac{1}{3800000}\right)^{\frac{1}{4}}$, or as 1 to 0·98. That is to say, steel shafts, to offer the same resistance to external transverse strains, may be two per cent. less in diameter than wrought iron shafts. The weights of such steel shafts will be about four per cent. less than the weights of wrought iron shafts of equal stiffness; and the power required to overcome the friction of the bearings will be about 6 per cent. less.

Lowell Mass., May 4, 1867.

(Continued from page 304.)

THE NEW YORK "CENTRAL PARK."

By WILLIAM H. GRANT, Superintending Engineer.

SHOULD such an amount of rain fall at a time when the grounds were covered with a considerable body of snow, and the grounds not frozen, the accumulation of water might so much surpass the capacity of the gutters and drains, as to cause the gullying of the roads and grounds. But the simultaneous occurrence of such contingencies,

although possible, is not to be regarded as so probable as to cause very great apprehension, or to justify the construction of works on a scale that would be fully adapted to meet it. The drainage system for the roads of the Park, adapted as before stated, to a rain-fall of two inches in depth in one hour, is believed to possess about the maximum capacity that is reasonably practicable or desirable for such purposes under similar circumstances. It is on a somewhat larger scale than is generally adopted for city drainge, but if any doubts were remaining upon the subject, they would not be on the side of a reduction of the capacity.

Before describing the details of the drainage works pertaining specially to the roads, the following description of the connected and more extensive system of surface-drainage of the Park will not be out of place.

* The larger drainage areas of the Park have, besides the principal basins and depressions into which the water descends, other subordinate depressions and irregularities of surface, of various extent, through which the drainage water must pass, and which would form pools in many cases during rains, if proper arrangements were not made for discharging the water. There are also districts of ground in which the natural water-courses have been unavoidably obstructed by the works of the Park, forming artificial basins, which would be liable to become ponds at times of excessive drainage, if ample outlets were not provided.

Special attention has been given to all such cases, to prevent the lodgment of water. Under-drains of ample capacity have been laid, and the water admitted to them by inlets with grated covers, or where practicable, natural depressions have been modified in extent, and the ground so shaped as to give them outlets on the surface. In some instances, to guard against contingencies, double outlets are made, one communicating with a separate drain from the other, or communicating with the same drain or sewer, at a different point, where the capacity is enlarged.

Experience has shown that it is not safe to rely upon mere agricultural drains, however perfect they may be, to absorb and carry off sudden accumulations of water from any considerable area of depressed ground. Such drains act by a slow process of percolation under the most favorable circumstances, and are liable to become entirely inoperative for surface-drainage at times when they are much needed; as, for instance, when the ground is temporarily and lightly frozen, or when it has been frozen to the greatest depth, and is gradually thawing out, the lowest portion of the frozen stratum remaining unaffected and impervious for a considerable length of time. At

* From Report of Superintending Engineer of January 1, 1862.

such times, standing water on the surface for a longer or shorter period, must result from a thaw of snow or from rain, and if no other drainage ensues, lawn grass and shrubbery that might be submerged would be likely to receive serious injury.

The surface and under-drains for the grounds at large, connect with the road-drains, and together make up a common system.

Besides the drains here alluded to, that lie below the surface, other drains, water channels, paved gutters and catch-water drains, or "sod-gutters," lying upon the surface, form a part of the system.

Where drainage water is brought to the roads from adjacent higher ground, it is generally intercepted by sod-gutters in the manner hereafter described under the head of *walks*.

The drainage of the roads is received into the under-drains below, through strongly grated inlets in the road-gutters. [Plate II.] The wider roads have under-drains to each gutter; the narrower roads have but one under drain. In the latter case, branch drains crossing the road connect the gutter inlets that are on the side of the road opposite to the main drains, with these drains. The inlets are placed from two hundred to five hundred and fifty feet apart (generally two hundred to three hundred feet apart), and are in all cases constructed with silt basins at the bottom, to catch and retain any substances that would otherwise be carried into the drains.

The road-drains and adjoining sod-gutters discharge, at various convenient points, into larger under-drains or sewers, and thence the water is conducted to the ponds or to the drainage outlets of the Park.

The road-drains are variously composed of stone or earthenware, vitrified and glazed pipes, cement pipes and brick sewers. The vitrified glazed pipes have been the most extensively used. Cement pipes were introduced upon the Park after the work had been considerably advanced; they are of quite recent manufacture in this country, and were recommended by their cheapness as compared with the earthen pipe. They are made of hydraulic cement and sand and gravel, intermixed in the form of a mortar, and are moulded with accuracy, and are submitted to pressure during the process, by means of machinery. When thoroughly made of the best materials, they possess the necessary strength and other qualities required for drain-pipe. They cannot be safely used, however, without being first subjected to such tests as will prove the indurating and hydraulic properties of the cement, which latter material is the important ingredient in their composition. They are not quite as perfect in their operation in conveying and discharging water as the earthen *glazed* pipes, as the latter pipes, from the superior smoothness of their interiors, cause less friction and retardation of the water, but they are superior to brick sewers in this respect.

In the use of the earthen pipes, they were found to be cheaper than brick drains, for all the smaller sizes of twelve inches and under. The cement pipes, as compared with brick, are ordinarily cheaper than brick, up to sizes of about twenty-four inches, which are the largest that have been used on the Park.

Previous to arranging and laying down these pipes along the roads, the areas of drainage surface for the different widths of roads were computed, together with such exterior drainage as was immediately connected with the roads, and the sizes of the pipes were graduated to receive the accumulated water entering at successive points from the summit to the foot of each descent in the line of the roads, or to such points where the pipes, from the necessary increase of capacity, give place to larger sewers that conduct the drainage in various directions, to the Park ponds or to the drainage outlets of the Park.

A specification of the manner of laying these drain pipes will be given hereafter.

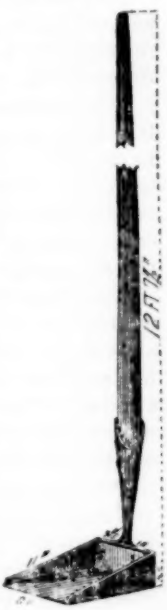
SILT BASINS.—A. B. & C. D., PLATE II.

These basins, as before stated, are constructed in connection with the road-gutters, at distances of two hundred feet to five hundred and fifty feet apart, along each gutter. They are adapted in capacity to receiving and retaining such quantity of silt, mud or road detritus, as is likely, under ordinary circumstances, to be discharged into them during a heavy rain of the duration of twenty-four hours. They are very seldom filled in that space of time, and only hitherto in exceptional cases arising from the washing of newly made slopes adjoining the road, or of gravel from the road, that had been freshly deposited and not rolled or compacted before the occurrence of a heavy shower. They will hold about a cart load of silt below the level of the outlet or discharge pipe. Their object is to prevent silt or other substances from being carried into the drain-pipes and obstructing their flow.* The bottom of the basins is generally five feet below the surface of the road-gutter, the outlet or connecting pipe between the basin and main road drain being about three feet below the gutter. The connecting pipe has usually a descent, before entering the main drain, of a few inches, to obviate any liability of

* They also serve a good purpose in partially relieving the drainage water of the roads from sediment and impurities before it reaches the filters and depositing basins that pass the drainage water into the Park ponds.

the larger volume of water flowing through the main, being diverted into the basin. Some of the basins first constructed, were inserted directly in the line of the main drains, the latter entering and discharging in the basin on one side, and passing out on the other. [Plate I., Telford road.] This method was considered objectionable on account of its checking the flow of water through the pipes, and also for the reason that the agitation of the water in the basin by the passing current, tended to prevent the desired deposit of sediment. The preferable plan of keeping the main pipes separate and a few feet distant from the basins, and connecting them by a branch-pipe, has been generally adopted. [Plate I, gravel road.] The mains follow as nearly as practicable, the lines of the road-gutters, turning aside at the points where they pass the silt basins, and occasionally diverging to the right or left, to avoid embedded boulders or projecting portions of rock.

Fig. 1.



The silt basins are constructed of hard, thoroughly burnt brick, laid closely and tightly in hydraulic mortar; the upper part above the level of the outlet pipe, is covered over, except the aperture communicating with the gutter, with strong flags or flat stones. Upon this covering is built up the neck of the basin that supports the gutter grating. The grating is twelve and a half inches wide and twenty-four inches long, the bars being two inches deep, and is strongly made of cast iron, and fitted like a lid to a cast iron curb or box that is supported by, and forms a part of, the neck or inlet of the basin.* The gutter stones are joined up around the curb, the surface of the gutter coinciding with the top of the grating. The grating is easily lifted off and replaced in cleaning out the basin. A small scoop of sheet iron attached to the end of a pole ten to twelve feet long, (Fig. 1,) is used in removing the silt, which is first deposited in a heap on the road near the gutter, and when sufficiently dry is hauled away.

The basins are examined from time to time, and the directions are that they be cleaned out in all cases, before the deposits accumulate

* The gratings weigh eighty-eight and a half pounds; the curbs weigh ninety-three pounds each

to such an extent as to endanger their being carried into the drain-pipes. The water standing in the basins, usually up to the level of the outlet pipe, is protected, by the depth below the surface of the ground, the contracted aperture, and the grating covering the top, from freezing in winter, so as to injure the masonry of the walls. The following remarks on the general drainage of the Park will not be without interest in closing this description of road-drainage.

*A recapitulation of all the works that have now been constructed for superficial and sub-drainage, and for supplying the Park with water, consisting of sewers, pipes and tile drains, and the iron and cement water pipes, shows an aggregate linear extent of 398,764 feet, or 75½ miles. The completion of the several systems will make this aggregate about 110 miles.

It is worthy of remark, that this extent of work, which performs so essential a part in the successful improvement of the Park and in developing its attractions, is wholly under ground and hidden from observation.

The statement of the aggregate linear measurement, together with the brief descriptions that have been given of some of the leading parts, will suffice to give a general knowledge of the scope of the work and of the amount of labor involved; but it is only by a reference to the working maps and plans in detail, that an adequate idea can be formed of the entire arrangement, adaptation and working of the respective systems.

The large area of the Park which is broken into undulations of all degrees, from precipitous to long gentle slopes, receives the heaviest showers of summer, and the water, instead of accumulating in rushing streams and gullying the grounds, quietly and harmlessly disappears below the surface, and is gathered into the veins and arteries of the drainage systems, and passed off to supply the ponds, or is discharged from the Park in the same unperceived manner. When a shower has subsided, its inconvenient effects soon disappear, leaving undisturbed lawns, and the roads and walks comparatively dry and fit for immediate use. The Croton water, at all points where it is desired, appears at command, or ascends in fountains at the appointed places; but the 110 miles of channels and the various connected works through which all this is performed, are unseen, and show no evidence of the connection that exists between the effect and the cause.

The direct practical results alone, are all that will arrest the attention of visitors or ordinary observers. Other works of the Park exhibit to the view their various purposes of utility and ornament, in more or less detail, and are accessible for inspection and repairs; but these spread out beneath the surface their extended reticulations,

* From Report of January 1, 1862.

and perform their principal functions silently and unseen, and can be approached and examined only by indirect means.

These facts give to this class of works a special interest, and show the necessity of special care and attention being given to works so situated, to maintain them in successful operation.

(To be continued.)

From the London Mechanic's Magazine, April, 1867.

STEEL WIRE.

STEEL wire is now chiefly used in the manufacture of needles, fish-hooks, springs, music-strings, small tools, umbrella frames, crinolines, and ropes, both for the home and foreign trades. Its application to ropes and cables is of very recent date, and is entirely owing to the success of Mr. Horsfall's invention; ordinary steel wire being manifestly useless for the purpose, and absolutely dangerous. As soon as it became known that a steel wire could be produced which combined all the advantages of lightness with hardness and extreme tenacity, it obtained a considerable share of popular favor; and, although it has been introduced within the past seven years, it has already attained a high position in the estimation of consumers, and, as prejudice is more and more overcome, must some day attract still greater attention. The steel wire rope is now used at many collieries; and is highly valued in deep pits especially, where the light weight of the rope is of such importance, both in connection with the safety and economy of the working. For railway inclines, lifts, and even ship's rigging, the same reasons are rapidly bringing it into use. Not the least important of the various mechanical inventions of the present day, which the introduction of a suitable quality of steel wire has materially assisted in perfecting, is the application of steam machinery to agriculture. The late Mr. Fowler has more than once declared "that he owed the success of his plough to the introduction of Webster and Horsfall's steel wire." But the most important use to which this wire has yet been adapted, and the one which is now exciting such universal interest, is the manufacture of submarine telegraph cables. During the past five years, large quantities have been used for cables in the Mediterranean; and lately, as is well known, it has formed an important and successful portion of the Atlantic telegraph cable. The manufacturer of this wire, in its various departments, kept nearly 250 hands employed for eleven months, the total quantity supplied being over 30,000 miles in No. 13, I. W. G. (=·095). We take the foregoing from Mr. Timmins's "Birmingham and the Midland Hardware District."

Mechanics, Physics and Chemistry.

LECTURES ON VENTILATION.

Delivered before the Franklin Institute, by L. W. Leeds, Esq.

LECTURE II.—(Continued from page 328.)

It is in connection with this system of heating by circulating warm air, that the erroneous views in relation to ventilation generally entertained by the public, produce the most injurious effects.

The special points to be borne in mind in considering this subject are that, when in motion, warmer air rises and colder air falls; but when at rest, the stratums of air of different temperatures arrange themselves horizontally.

One other thing: we must remember *temperature* has nothing to do with the purity or impurity of the air. The pure air entering a room is *sometimes* colder than the average temperature of the room, and falls to the floor, forcing the warmer, and, in that case, fouler air to the upper part of the room.

But frequently, in winter, the fresh air enters *warmer* than the average temperature of the room, and *rises to the ceiling*, and flows across the room above the colder and fouler air that has been longer in the room. You must not forget the experiments in our first lecture, showing that the breath in an ordinary room, of a temperature of 70°, fell to the floor instead of rising to the ceiling. I propose illustrating this part of our subject, by using a little glass room to show the movements of air of different temperatures. We can either use air of different temperatures, showing the motion of the various currents by a little smoke; or, as the laws governing the circulation of liquids of different densities are so similar, and by the use of a little coloring matter will express to an audience of this kind more promptly and clearly the ideas which we wish to convey, we therefore propose using the different colored liquids this evening.

The colors, of course, have nothing to do with the densities, but are merely used as a convenient method of designation; the red representing heat or lightness, and blue coldness or density.

The room is now filled with clear water, slightly blue, to represent cold, and a little salt, which makes it a little more dense than fresh water. Now, I will let in a little fresh water, colored red by cochineal,

to represent heat, and by making a similar opening on the opposite side for its escape, you will be able readily to see in what direction it moves. There, see it entering—see how it flows directly across the top of the room, and escapes at the opening on the opposite side. You see it disturbs the lower and colder parts of the room but very little. Thus a large flow of pure fresh warm air might be going through a room all day, and be entirely wasted, neither warming nor ventilating it. Fortunately, there are but few buildings arranged in quite so absurd a manner as this. I believe it was tried in the House of Lords, on the erection of the new Houses of Parliament, but, of course, failed. I think they still adhere to it in some of the wards of some Insane Asylums, where they depend, I suppose, upon the excitement of the patients to keep themselves warm and the air stirred up. I also noticed this arrangement in a new building just being finished, a few years since, at Yale College. The architects of that building had probably been impressed with the dreadful effects upon the health of students of the air from our ordinary hot air furnaces, and thought they would avoid all such danger. I think, however, it would have answered their purpose just as well, and been much more economical, to have placed the furnaces at the coal mines, and saved the trouble and expense of carrying the coal so far. I expect they have made other arrangements, probably, by this time.

We will now close the opening at the top for the *inlet* of the fresh warmed air, and open a valve, so as to allow it to flow in at the bottom. We will allow the opening at the top for the *outlet* of the foul(?) air to remain as before, (see figure one, lithograph plates.) This is quite an improvement; it agitates the air much more than the other, and by going and standing directly over the register, you can always get in the current of fresh warm air. But you see to what a very small portion of the room the heated air is confined, rising in one perpendicular column directly to the ceiling, and then flowing horizontally along the ceiling to the outlet. How little it disturbs the main portions of the room, especially the lower and occupied part.

I hope you will notice that this illustrates the popular notions of ventilation. I suppose three-fourths of all the buildings in this country, or in Europe, where any attempts at artificial ventilation have been made, are thus arranged. Dr. Franklin knew better, and made a much more perfect arrangement than this. But we are probably mostly indebted to that very able and enthusiastic advocate of ventilation, Dr. Reid, for this popular opinion. The whole of the plan

that he advocated is but little understood by the public. He assumed that the natural warmth of the body created an ascending current around us, and caused the breath to rise towards the ceiling, and consequently, in all artificial arrangements, it was best to endeavor to imitate this natural movement of the air. And to overcome the great practical difficulty we see here exhibited, of the fresh warm air flowing through the room, and disturbing so small a portion of it, he proposed making the whole floor one register, and thus have an ascending column over the entire room. For this purpose, the floors in the Houses of Parliament were perforated by hundreds of thousands of gimlet holes, and the whole cellar made a hot air chamber. This was a magnificent idea, and, I believe, in some few instances, where fully carried out, has given a good degree of satisfaction; but it is always difficult to adjust the opening and the pressure so as to cause an even flow over so large a surface, and at the same time to be so gentle as not to be offensive to those with whom it comes in contact. But this thorough diffusion cannot be conveniently applied in one case in one thousand. It must necessarily be always very extravagant, as it will always require a great amount of air to insure a thorough circulation through all parts of the room. I wish, therefore, most emphatically, to condemn all systems relying upon openings in the ceiling for the escape of the foul air while depending upon the circulation of warmed air for obtaining the necessary additional warmth. In practice they are universally closed in winter, for the purpose of keeping warm, and as such openings have been so generally considered the *only* ones necessary for the proper ventilation of a room, and as they had to be shut in winter, just when artificial ventilation was most necessary, it has created a very strong prejudice in the popular mind against all ventilation.

The result of the advocacy of these impracticable theories by so many able and learned men, (most physicians writing upon this subject have adopted them,) has been the shutting up of many thousands and tens of thousands, till they have smothered to death.

The ravages of consumption and the excessive infantile mortality, and the many diseases resulting from foul air poisons, are in a great measure due to the general advocacy of these false theories. As I have before said, Dr. Franklin knew better than this, and had we been contented to have followed his simple practical advice, instead of being dazzled by the splendid theories of others, thousands of our friends would now be with us who died long since for the want of fresh air.

Now, let us see how Dr. Franklin says a room ought to be ventilated, He says, "the fresh air entering, becoming warmed and specifically lighter, is forced out into the rooms, rises by the mantel-piece to the ceiling, and spreads all over the top of the room, whence, being crowded down gradually by the stream of newly warmed air that follows and rises above it, the whole room becomes in a short time equally warmed." This is the principle upon which his celebrated Franklin stove was arranged. Now, let us see if we can arrange our little glass house so as to illustrate this. We will first fill it with what we call our cold air, and will close the outlet at the top, and take out the fire-board. Now, as I let in the warm fresh air, it rises immediately to the top, as before, and flows across the ceiling, but as it cannot escape there, it forces the cold air down, and causes it to flow out at the fire-place. See how quickly the whole room is filled with the fresh warmed air. Ah! I see I am a little too fast—there appears to be a stratum of a foot or two, lying on the floor, that is not disturbed yet. It flows out at the top of the fire-place, and therefore does not reach to the floor. This is frequently the cause of cold feet and much discomfort. We will make the opening directly at the floor, (see Fig. 2, Lithograph plate,) and that forces all the cold air out, warming and ventilating the whole room. Here is the whole problem solved in the most beautiful and simple manner. And you may exclaim, as you see the simplicity and perfect working of this, how came any one ever to think of anything else.

Here, again, you see the value of that most excellent and valuable of household arrangements, the open *fire-place;* even without the fire it serves a most important purpose.

We must not forget, however, that there are other circumstances in which it will not do to depend on the fire place alone for ventilation. Now, by leaving the fire-place open, just as it is, and the room full of warm air, we will simply change the *condition* of the air supplied, and allow cold air to flow in at the bottom instead of top. (See Fig. 3.) There, you see the fresh *cold* air simply falls to the bottom and flows across the floor, without disturbing the upper part of the room at all. It acts just the reverse of the hot air let in and taken out at the top of the room. When you are ventilating a room by *opening a window*, therefore, it is often necessary to open it at the top; but remember when you are ventilating by doors and windows, (which are the great natural ventilators,) *they* are an entire substitute for flues—flues are then of no account. All *windows*, therefore, ought to be

made to *lower from the top*, and all ventilating *flues* ought to be made to *open at the bottom* of the room.

I have noticed another very interesting feature in regard to the circulation of liquids of different densities; for instance, suppose we fill our little room half full with salt water, and the remainder with fresh water, we will now apply a spirit lamp to the bottom of the room. As the salt water becomes heated it rises rapidly, but not to the top of the room, but only half-way, or to the top of the denser liquid, and then spreads across the room horizontally. Thus the salt water will keep up a rapid circulation, and may be heated almost to a boiling temperature *underneath* of, and without heating or disturbing, the cold fresh water *above*. I have tried some very beautiful experiments of this kind with a number of liquids of different densities in the same vessel. Gases of different densities are probably influenced in a similar manner by the application of heat. And here we see the value of that beautiful law of the diffusion of gases, by which each gas, no matter what its density, is equally diffused in all directions through the other gases, independent of temperature.

I desire to call your attention this evening to one other distinct system of heating—I mean that very convenient, economical, cleanly and very FASHIONABLE system of heating by direct radiation from steam-pipes.

As steam has become such a common article in all large buildings, both for power and as a convenient means of distributing heat, most large buildings are thus heated, and as a perfectly air-tight building can be very easily heated thus, and as most persons are too ignorant or too careless to provide a separate and distinct supply of fresh air simply for ventilation alone, the consequence is, that this system, thus so shamefully abused, is probably drying up more talent and killing more business men in our cities than any other system in existence. This applies especially to the editorial rooms of nearly every one of our leading newspapers and publishing houses. They use steam for driving their beautiful printing presses, and the heating and ventilation, or rather, the entire want of ventilation, in their offices, would indicate that they thought that the same power that drove their presses, to do the printing so nicely, was entirely sufficient to drive them to write the original articles for the printer, and that they had no more need of *fresh air* than their presses.

You may think that I am certainly mistaken that so intelligent a class of the community, who are building such splendid fire-proof build-

Fig. 1.

Fig. 2.

Fig. 3

ings, such perfect palaces of iron and stone and marble, as our newspaper establishments are building in New York, Philadelphia and other large cities, would never make such a blunder as to omit providing the most abundant supply of pure, fresh air to every employé in their establishment, and at all times, both in summer and winter.

Should there be any one present thus doubtful, I wish he would undertake to get any one of our enterprising newspaper establishments to publish in their paper an accurate intelligible account of their system of ventilation, illustrating clearly the known quantity of pure, fresh air delivered within using distance of each one of the editors and employés.

I think he would soon come to the same conclusion I have, that the advice of the minister to his congregation would be very applicable to them—"Always do as I *say*, but never do as I *do*."

(To be continued.)

LECTURES ON MINERALOGY.

By Theodore D. Rand.

LECTURE I.

CLASSIFICATION, NOMENCLATURE, CRYSTALLOGRAPHY, CHEMICAL COMPOSITION, COLOR, HARDNESS, SPECIFIC GRAVITY.

Mineralogy and *Geology* are so allied that many persons regard them as almost identical; but the distinction is very clear, and may be given in a few words.

Geology studies the *rock masses* which form the crust of our globe. Mineralogy studies the *minerals* which form these *rock masses*. The whole number of these minerals is not much over six hundred, but notwithstanding this, few sciences have suffered more for want of a judicious, systematic nomenclature and classification. The object of nomenclature and classification is not to draw supposed natural lines dividing minerals, for such nature does not draw. Her plan admits, neither in the mineral, vegetable nor animal kingdom, of well and clearly defined lines, but from the animalculæ, and even from the vegetable, to man a ladder is found, the steps of which are almost in contact. By this, I do not mean to encourage the unscientific development theory, that the higher organisms have sprung from the lower, (for no evidence of such has ever been found,) but simply that the

fact which gave plausibility to the Darwinian theory, that there are closely connecting links between every division which we may make, prevails in mineralogy, as in all other sciences.

The real object, therefore, of all classification should be the arrangement of the species in that order, and in such groups, as shall most aid the memory in studying their peculiarities, and shall, as far as possible, place species having strongly marked similar characteristics, together. In Botany, Zoology, Conchology, &c., the vast number of species, and their various common names, have rendered it necessary to give to every genus a name, to which is added another for each species in that genus, each name being, as far as possible, founded upon some characteristic of the species. The comparatively few mineral species and the comparatively few common names render a classification of this kind cumbersome, and productive of greater evils than those we would avoid.

Professor Dana, abandoning the pre-existing arrangements, offered, in his edition of 1857, a classification of this kind, giving new double Latin names to all minerals, and subdividing minerals into classes, orders, genera and species, but it found no favor with mineralogists, and was abandoned by him in his third edition, in which he says: "There are errors in its very foundation, which make it false to nature in its most essential points, and in view of the character of these errors, we are willing it should be considered a relic of the past."

Based upon the system of Mohs, Werner, Brochant and others, arose a classification by which, probably, the majority of cabinets are arranged, and which is that used by Dana in his third edition. This divides minerals into seven classes, by chemical composition. Four of these contain, in the aggregate, but thirty-five species—the remaining three are subdivided according to their chemical bases, two of them into six groups, the third (metallic) into fifteen. Inasmuch as the base in any mineral is generally characteristic, easily ascertained and remembered, and especially in metallic species those of the same bases occur naturally together, this is a most convenient arrangement for ready reference and memory. There are, it is true, objections to it, probably the strongest being, that many bases, being isomorphous, may be indefinitely substituted one for the other, but this objection will be found more apparent than real, for many of the isomorphous bases are grouped together, as for example, lime and magnesia.

In Professor Dana's fourth edition, he has arranged the species after a strictly chemical crystallographic system, giving prominence chemically to the electro negative, or the acid of the compound. There are many advantages in this system. It is perhaps the most scientific arrangement, but it would be most difficult of acquisition, there being few of the aids to memory of the former system, and there being but one hundred and sixteen groups; but the gravest objection is, that it brings in juxtaposition the most dissimilar minerals and separates those closely allied. Thus, periclase and red copper, carbonic acid and quartz, calamine and prehunite, alunogen and brochantite, oxide of zinc and water, are placed in juxtaposition, while metallic iron, specular iron, magnetic iron, brown hematite and gœthite, almost identical in chemical composition, varying but in content of oxygen and water, and naturally associated, are distributed through four grand divisions and five groups. The ordinary well known ores of copper are similarly distributed through six grand divisions and seven groups.

The following is the classification by bases above referred to, slightly altered from that of Professor Dana, by making divisions of some of his subdivisions.

I. Nitrogen, Hydrogen.
II. Carbon, Boron.
III. Sulphur Selenium.
IV. Salts, non-metallic, not silicates, (Hydrates, Sulphates, Carbonates, Phosphates, &c.)
A. Salts of Ammonia.
B. " " Potassa and Soda.
C. " " Baryta and Strontia.
D. " " Lime and Magnesia.
E. " " Yttria, Ceria, Thoria, &c.
V. Silica and Silicates, not metallic.
A. Silica.
B. Hydrous Silicates and Boro Silicates of Lime and Magnesia.
C. Hydrous Silicates of Magnesia.
D. Anhydrous Silicates of Lime and Magnesia.
E. Hydrous Silicates of Alumina.
F. Zeolites.
G. Anhydrous Silicates of Alumina.
H. Feldspar and allied minerals.
I. Garnet do.
K. Mica do.
L. Aluminates of Magnesia.
M. Silicates of Glucina.
N. do. Zirconia, Thoria Yttria, &c.
VI. Metals and Metallic Ores.
A. Tin, Titanium, Molybdenum.
B. Titanates, Columbates, Tungstates, &c.
C. Uranium.
D. Bismuth, Tellurium, Antimony, Arsenic.

E. Chromium.
F. Iron.
  1. Sulphides.
  2. Oxides.
  3. Salts not silicates.
  4. Silicates.
G. Manganese.
  1. Sulphides.
  2. Oxides.
  3. Salts not silicates.
  4. Silicates.
H. Cobalt, Nickel.
I. Zinc, Cadmium.
K. Lead.
L. Copper.
M. Mercury.
N. Silver.
O. Platinum and associated metals.
VII. Resins, or organic compounds.

Of course, in this arrangement, the word metal is used in its popular sense.

(To be continued.)

From the London Engineering, No. 70.

PUMPING BY WATER POWER.

THE April number of *Les Annales du Génie Civil* contains a paper by M. Achard, descriptive of the water-works carried out under his direction for the supply of two suburbs of Geneva, known as Petit Saconnex and Grand Saconnex, the latter elevated 104 metres, or 341 feet, above the level of the Rhone, a little below where it leaves the Lake of Geneva. The river, here—and it is here that Bonnevard (the Prisoner of Chillon) was supposed, by a fiction of poetry, to have seen it when he spoke of the "Blue Rhone in fullest glow"—has a current sufficiently swift to work a large paddle or undershot wheel for driving pumps, and water-power pumping works have accordingly been erected by MM. Menn, Lullen & Co., engineers, of Coulouvrenière, near Geneva. These consist of a wheel, 33 feet 6 inches in diameter and 20 feet face, driving a pair of double-acting pumps, of a collective capacity of $6\frac{2}{3}$ gallons, or $13\frac{1}{3}$ gallons for the double stroke, at four times the speed of the wheel itself, the ratio of the gearing being as 4 to 1. At $2\frac{1}{4}$ revolutions of the wheel per minute, 120 gallons per minute are thus pumped. Including friction and all resistances, the pumps work against the great resistance of 472 feet of water. The usual speed of the water-wheel is, however, $1\frac{3}{8}$ turns per minute, and the corresponding head, including friction, is 380 feet.

ERECTING THE INVERTED IMAGE
IN THE MAGIC LANTERN.

By HENRY MORTON, Ph.D.

A LENS, as every one knows, inverts the image which it makes of any object; hence, in the magic lantern, we place the picture upside

down, and right for left, in order that its image on the screen may occupy a true position. This is the shortest road out of the difficulty, of course, where it can be followed; but there are many cases in which such a treatment of the subject is inadmissable. Thus, if we wish to exhibit to a large audience the manner in which tacks or iron filings are vivified by a magnet; how water assumes the spheroidal state on a heated surface; how the same fluid is caused to circulate by local changes of temperature, or is decomposed by a galvanic current, or any of the many similar experiments which may be conducted with striking effect in a lantern, we must resort to some means other than "inversion of the object" to secure an erect or right-side-up position of the image on the screen.

The desirability of some means for reaching such a result is very manifest, and the most natural first thought is to use a square prism, as described by Brewster in his Optics, page 270, where a drawing is given, curious at once for its theoretical accuracy and practical impossibility; an equilateral triangle being taken to represent a square prism, and the refracting action indicated as about eight or ten times as great as it could possibly be. Yet, viewed as a symbol or hyroglyph, this drawing, as will be shown presently, may be regarded as embodying actual results, which, if known to the author, were certainly not hinted at, and to the best of our belief, will find their first publication at this time.

A more accurate drawing of the same thing is to be found in Frick's *Physical Technics*, (an admirable work, which should be in the hands of every experimenter and manufacturer of apparatus,) page 209.

With such authority, we should have proceeded to experiment, but for the information, from one who had given much attention to lantern manipulations, that the plan had been tried and abandoned by him, in consequence of the loss of light and reduction of field which it entailed. Professor R. E. Rogers, who had gone further than we, and had made some experiments, was, we believe, deterred from further attempts by the same cause.

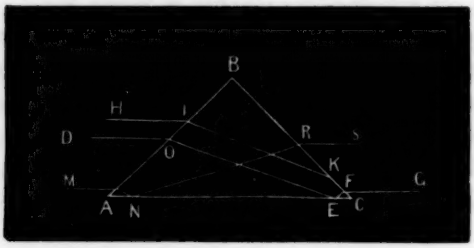
A trial, however, was at last made which satisfied us that, under proper conditions, a good result might be realized with a square prism, placed in front of the objective of an ordinary lantern.

The accompanying cut, which is drawn with some attention to accuracy of direction and angle, will show, on inspection, how the upper and under rays, D and M, change places, and thus how the inversion is corrected. In using this prism, no inclination is given to the lan-

tern. It remains directed to the screen, exactly as with the inverted image.

The loss of light experienced is not serious, so that we are able,

Fig. 1.



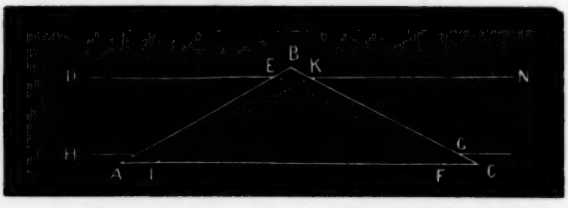
with an ordinary lantern, to cover a screen of twenty feet in diameter with a brilliant circle of light; while the contraction of field, though notable, is not of any practical inconvenience.

The only drawback was the difficulty and cost of obtaining prisms large enough, and this difficulty has been overcome by the ingenuity of Mr. Zentmayer, who has devised the excellent improvement we shall now proceed to describe.

Observing that with the square prism, only the lower portion is available, any ray above D, Fig. 1, such as H, for example, failing to strike the base and be reflected, but suffering reflection downwards at K, and so being lost, he proposed to make the prism of such a shape as is indicated in Fig. 2.

Here the angle B is calculated to equal the angle of refraction of

Fig. 2.



an horizontal ray, such as D at the surface A B, plus 90°. Under this condition, such a ray, after refraction, would be parallel to the further side, B C, and would therefore reach the base, A E, and be reflected from it, however near to the summit, B, it might strike.

The lower ray, H, would be in an equally favorable condition, as is clear from inspection of the figure.

The angle, B, is 125° 30′, A and C, of course, 27° 15′ each. It

might be thought that the great obliquity of the surface, A B, would cause a serious loss of light by reflection, but this drawback does not appear in practice.

The economy in thickness of glass required to produce a prism of given effect is decidedly very great. In fact, the ordinary optical glass, which is easily procured, answers perfectly; while for the square prism of sufficient size, it would be necessary to order blocks especially from the foreign manufacturers.

With regard to the curious *symbolism* of Brewster's drawing, we can now explain, that the rays, after refraction, were represented as proceeding in lines parallel with the faces of the prism, as in Fig. 2, though with a triangular, or even with a square prism, this was entirely impossible.

We do not wish to claim any originality in the use of a square prism, as above described, but only to call the attention of those interested, to the practicability and success of the arrangement. The form devised by Mr. Zentmayer is, however, we believe, entirely new, and certainly most efficient, and he is entitled to all the credit of its invention.

EDUCATIONAL

(Continued from page 356.)

THE MAGIC LANTERN

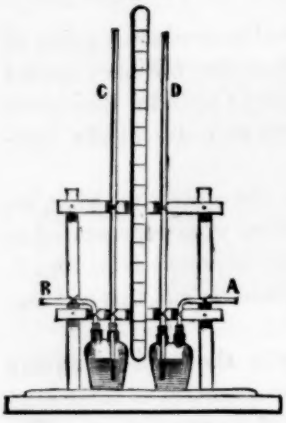
AS A MEANS OF DEMONSTRATION.

HAVING now pretty fully discussed the methods of preparing, and storing the oxygen and hydrogen gases, we will next proceed to describe the best form of jets for burning them, first, however, giving some account of a simple gauge, to indicate the pressure employed on the gases, which we have found of the greatest possible value and convenience.

A mere inspection of Fig. 8 will make this arrangement plain, almost without a description. The two bottles of two necks, such as may be obtained from chemical dealers, are blown from glass tubes, and hold about two ounces. The tubes are fitted to their necks by means of rubber corks, or short pieces of rubber hose used as corks,

and by this means a *perfectly* air-tight joint may be secured. It is well also not to make the long upright glass tubes continuous throughout; but, having inserted short pieces in the bottles, to connect these with the prolongations by short pieces of rubber hose. By this means the risk of breakage to tube or bottle is greatly diminished, and the ease of repair, should the former be fractured, is greatly increased. In practice, with much moving of the apparatus from place to place, we have never had a bottle, and but seldom a tube, broken. We need hardly say that each bottle and tube forms a gauge to a separate gas, the pair thus shown answering for the oxygen and hydrogen, in an ordinary lime light. These gauges are fastened either beneath or upon the table used for the lantern. A small three-way, or T connection being attached at A and B, the gases on their way from the reservoirs to the stop-cocks which control the jet, exert a pressure in the bottles which is measured by the rise of the water in the tubes C and D. The height of these tubes should be from twenty to twenty-four inches. A scale of paper pasted on a strip of wood, placed between the tubes, serves to indicate the pressure registered by each.

Fig. 8.



These gauges enable one to make sure of the tightness of all joints in the connected apparatus; or, if a leak occurs, readily to find its position. Thus, the jet being shut off, we bring pressure on the reservoirs, gas-bags, or the like, and then turn on the stop-cocks leading from these, for a moment, closing them at once again. The gauges then, after rising, fall slowly if all is tight, though rapidly if there is a leak. Should a leak be indicated, turn on the gas from the reservoir, a little; then, pinching the flexible connections with the hand, find where the gauge will stand when thus cut off from the reservoir, and where it will fall. Between these points will be the leak.

The Jet.

After very extended experience with jets of many forms, we have become thoroughly convinced that the best and most satisfactory, both for economy and efficiency, is the simplest.

This form is shown partly in section at Fig. 9. It consists of a slightly tapering copper tube, of about one-tenth to one-sixteenth inch internal diameter, fitted into a screw-cap which is attached to a socket, in which meet and terminate the two tubes conveying the different gases. The copper tube is battered in at the end, and then has a small hole drilled through the flattened portion, so that the outlet is of the nature of a perforation in a diaphragm. With such a jet as this (the form devised and used by Robert Grant, of New York), the light will be concentrated, intense and perfectly reliable, so long as the pressures on the different gases do not differ by more than five or six inches of water, and are moderatly heavy, (ten inches of water, or over.) With great excess of pressure on one gas, the light will, of course, be bad, and if the excess is on the oxygen, there may be a snap or explosion in the jet, after which the flame will burn inside of it, giving very little light, and, of course, tending to injure the tube. This snapping, in such a case, is not due to the form of the jet. It will happen in any one in which the gases mix, even if the interior be filled with the wire gauze or other "safety" appliances. In the simple tube, however, the accident is easily repaired, while with the more complex arrangements it is more apt to give trouble, and may even lead to some danger. Thus, if the jet of this simple sort snaps, we at once turn off the oxygen gas, or both if we please, and should feel obliged to it for calling our attention to something wrong, which was undoubtedly wasting our gas, or impairing the light. We then at once look to the pressure as indicated by the gauge, and will be pretty certain to find that adjustment is there needed. More pressure on the hydrogen is required. Should the gauge say "all right," there may yet be two other causes of trouble; a kink in the hydrogen connections, which will be shown by an immediate fall in the gauge, on opening that stop-cock to the jet; or a bad adjustment of the stop-cocks themselves: to this we come back in default of other causes.

Fig. 9.

With these simple jets, then, all will go right so long as good conditions are maintained, and if these conditions are deranged beyond a certain limit, warning will be given which will oblige us to apply the necessary correction. Beyond this nothing can happen. With the free outlet furnished by the open jet, any mingling of the gases in the reservoirs is simply impossible while any light is being obtained

at the jet. If the pressures could be made so enormously unequal that one gas drove back the other, and entered its reservoir, there would be but one gas, and therefore no light, at the jet. Diffusion travels too slowly in narrow tubes to have any effect, where even a very tardy outflow is taking place.

With the so-called "safety-tubes" between the mingling of the gases and the outlet of the jet, there *may be* danger.

The great resistance which these offer to the outflow *may* enable some mingling action to go on if the supply tubes are short and large, the stop-cocks wide open, and the pressures unequal. We have yet, however, to hear of an authentic case of accident from this cause.

In one instance the jet snapped, and the retreated flame melted up the gauze and closed the jet. The stop-cocks being kept open while a new jet was being prepared, the gases, unequally loaded, mingled in one of the bags, which, on starting the new jet, gently exploded. This is the only case we have heard of in which the cause could not be traced to a badly ground dissolving stop-cock, careless mixing of gases in the same bag, or the like.

The "safety-tube," we seriously think, can afford little, if any, protection. The explosion of an oxyhydrogen mixture may occur through the best safety-tubes, on sudden relief of pressure, as has been shown by Prof. Hare and by Dr. Charles Cresson, and, on the other hand, the resistance offered by the wire gauze, and like material, is likely to do harm.

The best security is to adjust the stop-cocks of the jet in such a manner that they are neither of them more widely open than is necessary for the supply of the flame. Should the jet become overheated by the retreat of the flame, when it is not observed, it must then be cooled by a touch or two with a wet rag, or even by letting the hydrogen flow through it for a minute, before relighting.

Concentric jets, where the oxygen is supplied by an interior tube to the middle of the flame, are inferior for use in lanterns, because they produce rather a ring of light on the lime, than a single spot. This inferiority is most manifest in the gas microscope and polariscope, where great precision in collecting and concentrating the rays is required. In the ordinary magic lantern it is less noticed, but even there shows itself in the greater consumption of gas required, to produce an equal effect of illumination.

(To be continued.)

(Continued from page 358.)

LECTURES ON ELECTRICITY AND LIGHT.

Delivered before the Franklin Institute, by PROF. HENRY MORTON, PH.D.

SINCE the publication of the portion of this abstract which appeared in the last number of this Journal, we have learned from Messrs. Queen & Co. that the use of the internally silvered glass globe, there described, was suggested to them by Prof. Robert E. Rogers, of this city.

Before leaving the subject of the development of electricity by friction, it remains for us to give some account of that which is known as the Steam Electrical Machine.

The development of this apparatus originated with an accidental discovery made by a workman who had charge of a steam-boiler at one of the collieries near Newcastle-on-Tyne, England. He found that when one of his hands was in the jet of steam which escaped from a small leak near the safety-valve, and the other hand was brought near the metal of the boiler, sparks would fly between the hand and boiler, and a series of shocks be at the same time experienced.

This experiment was repeated, varied and extended, by Mr. W. G. Armstrong, H. L. Pattinson and others, but for a long time the true cause of the phenomena was not understood. Even Faraday at first supposed it to be the action "already known, and by some ascribed to mere evaporation, by others to chemical action."

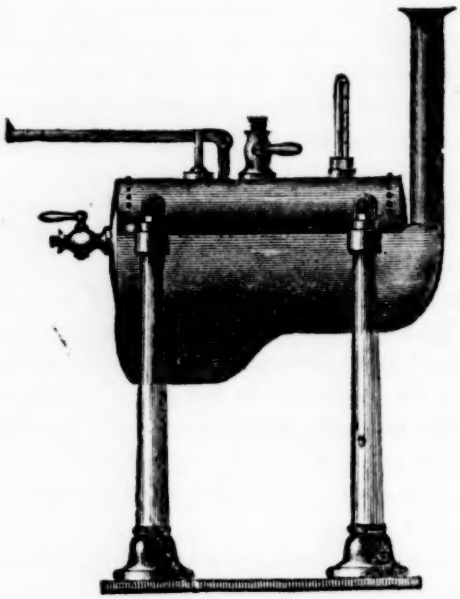
It was at last, however, found to result from the friction of particles of water carried out with the escaping steam, and rubbing against the material of the orifice. And it was shown by Mr. Armstrong, and since, in various ways, by others, that like effects may be produced with currents of air, and many gases, provided they are caused to carry spray of water with them as they escape.

The history of the first discovery and development of this subject will be found in the *Philosophical Magazine*, vol. xvii., pp. 370, 452; vol. xviii., pp. 50, 93, 95, 100, 328; vol. xix., pp. 25, 88; vol. xx., p. 5; vol. xxii., pp. 1, 486, 570; vol. xxiii., p. 194, and in the *Philosophical Transactions* for 1843, p. 17, where Faraday has given a very thorough discussion of the theory and experiments.

The apparatus required and heretofore used in the development of electricity in this manner, is very simple. A steam-boiler, internally

fired, is mounted on glass columns, (see Fig. 10,) by which means it is thoroughly insulated. This course is adopted because it is found better to employ that portion of the electricity developed in the boiler,

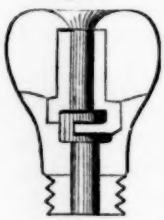
Fig. 10.



than the opposite kind produced in the escaping steam, and which can be less easily and thoroughly collected from points immersed therein.

This boiler is provided with a safety-valve and pressure-gauge, as indicated, and also with a large stop-cock in the centre above, to which is attached an horizontal pipe, carrying several nozzles of such a shape as represented in Fig. 11.

Fig. 11.



In this, the shaded portion in the middle represents the interior passage. The projection into this passage, near its lower part, causes the jet to pass into that immediately above, in a cup-like form, by which means a more violent friction, between the watery particles in the jet and the sides of the tubes, is secured. This interior portion should be of metal, the exterior, or cap, of wood.

(To be continued.)

Franklin Institute.

Proceedings of the Stated Monthly Meeting, April 17th, 1867.

THE meeting was called to order with the President, Mr. J. V. Merrick, in the chair.

The minutes of the last meeting were read and approved.

The Actuary submitted the minutes of the Board of Managers, and reported that, at their stated meeting, held April 10th, inst., donations to the library were received from the Royal Astronomical Society, the Royal Geographical Society, the Royal Institution, the Society of Arts, and the Institution of Civil Engineers, London, England; l'Academie des Sciences, Paris, et la Société Industrielle Nationale, Mulhouse, France; the Geological Society, Quebec, and Maj. L. A. Huguet-Latour, Montreal, Canada; Rear Admiral C. H. Davis, Superintendent of the United States Naval Observatory, and from the Superintendent of the United States Coast Survey, Washington, D. C.; the Ohio Mechanics' Institute, Cincinnati, Ohio; Mercantile Library Company; Dr. T. S. Kirkbride, Prof. Henry Morton, Messrs. Charles McManus and A. J. Demoret, Philadelphia.

On motion of Prof. H. Morton, it was

Ordered, that a vote of thanks by the Board of Managers of the Franklin Institute be presented to James Swain, Esq., for his exertions in promoting the interests of the Institute.

The President read a letter from Maj.-Gen. G. G. Meade, asking the Franklin Institute to take action in regard to a monument to the memory of Prof. A. D. Bache.

On motion of Messrs. Fraley and Wm. Sellers, it was

Ordered, that the letter be referred to the Institute, with the recommendation that a committee be appointed to take action in the object proposed.

The various standing committees reported their minutes. The Special Committee on Experiments in Steam Expansion reported progress. The Special Committee appointed to prepare a memorial to Congress, with reference to the establishment of a uniform Code of Danger Signals, reported progress. The Special Committee on the preparation of a draft of ordinance to provide for the Inspection of Steam Engines and Boilers in the City of Philadelphia, reported their minutes.

The Secretary's report on Novelties in Science and the Mechanic Arts was then read. (An abstract of this will be found in the Editorial Department.)

The following remarks, suggested by statements in the Secretary's report, were then made by Mr. Robert Briggs:

Mr. Briggs. In regard to this particular case, referred to by the Secretary, I will state that we had, at the Pascal Iron Works, a bearing of the main shaft of one of our mill engines, which carried a load, not exceedingly heavy, only some one hundred and sixty pounds per square inch on the bearing surface; not more than proper to carry, but at the running velocity of forty-six revolutions, more than it could sustain without heating and rapidly wearing. After experiencing a great deal of trouble with it, putting in new boxes every three months as a regular thing, I removed the pedestal and put in a new one, in which the lower bearing was a hollow brass casting, through which a stream of water ran constantly, cooling it down to such a point that the lubricant used was not dissipated. By this means, we have been able to keep the box in perfect working condition without appreciable wear, while running night and day for about three years. I did not mention this to the Secretary as anything new, but only as an instance to show that the heat produced by the friction of the shaft upon the bearing was an important element, and that I did not think we would be justified in saying, without qualification, that there is any definite load to the square inch which a bearing should carry.

We find that surfaces covered with oil maintain their oily character and loss of friction with much reliability for years. Take, for instance, an ordinary screw bolt, which is the simplest and most commonly turned thing anywhere. Its velocity of turning is exceedingly small, the common load for the square inch of surface on the thread of the screw is from eleven to eighteen thousand pounds. Under that load per square inch of surface, a well oiled bolt, once oiled, remains so. At almost any time it can be turned backwards and forwards, and can be used constantly and regularly without any undue resistance beyond the ordinary loss of friction—following directly the law of friction—the resistance of turning increasing directly with the load per square inch of surface. I name this as being the strongest possible case of a shaft having the minimum of velocity and the maximum of pressure.

When we come to apply the same conditions to ordinary journal bearings, the same rules obtain. The English habit of proportioning

the bearings of shafts have been justified by the experience of many hundreds of mechanics, and are perfectly correct. Thus, it is an habitual thing for them to state that about once and a quarter the diameter of the shaft is abundantly long for the bearing. This law is correct if three conditions are complied with, viz: first, that the shaft shall be of cast iron where the diameter shall be exceedingly large as compared with its strength; second, that its velocity shall be low, which is the condition of all English shafting; thirdly, that many belts should not be used, belts producing heavy straining upon the surface of the bearings. Under these three conditions, the English rule is obviously correct in practice, and can hardly be impugned. We cannot apply the laws at present used in ordinary bearings for cotton machinery to propeller shafts, where the load to the square inch is light, and even where it is heavy on the main bearings of these shafts. We find we cannot increase the length without heating more seriously from the increase of length than we should have done by decrease of bearing surface. It has been a mistake with many eminent mechanics of exaggerating the length of the main bearings, and, as a result, finding they could not drive the engine. The proportions adopted in propeller engines serve as a very admirable guide for the proportions required under the circumstances, and they would be found, under examination, to show that the rate of velocity, as well as the weight, is to be taken into consideration.

Looking at the matter in a more theoretical manner, we see that the box has to carry a certain weight under a given velocity, and to maintain a certain friction, producing a definite amount of heat. If the movement of heat be not dissipated by the external surface of the box, it will go on accumulating until it reaches some point at which the lubricating material will cease to be a lubricant. Our oils change in character under an increased temperature. Sperm oil, up to 180° to 200°, is a very fair lubricant. On the contrary, lard oil, at 110°, ceases to be a lubricant at all; it flows freely from the sides of the box, leaving it comparatively stripped and naked, when an abrasion of material takes place with great rapidity, the box heats, and is gone. That which I want to state distinctly is, that the journal-box itself should, in some way, act in dissipating the heat generated by friction. For this reason, we find the weight of the box has some value.

If the shell of a bearing is too light, or is too isolated from contact with its pedestal, if it be set in wood or other non-conducting material, the chances are that, with a light load and with a low velocity, and

with careful lubrication with a good lubricant, it will heat excessively. On the other hand, a heavy shell well bedded in an iron frame, and exposed to the air, will disperse the heat of rotation or friction of a shaft, under unfavorable circumstances as regards load, or surface, or velocity.

So far as the materials which constitute bearings are concerned, those which are the hardest, and which will not abrade into angular fragments, are those best adapted for forming both shaft and box. It is important that the materials should be such as will run with the least amount of friction upon each other. Thus cast iron upon cast iron does not behave so well as wrought iron on itself or on cast iron. Wrought iron on cast iron is admirable, but the moment either the velocity or the load becomes excessive, brass is far superior to cast iron, because it is a so much better conductor of heat. Pressure cannot be taken as the sole basis of friction. We have four or five kinds of bearings. The condition of a shaft turning upon a point or end surface is altogether different from that of a shaft turning in a box, so far as the lubricant is concerned. In the former case, the oil, by its very rotation, is carried from the centre outwards. On this account, in all fast running, and in fact in all running of vertical spindles, it is better to arrange gutters which shall permit the oil to enter the centre and pass out on the outside, running the whole end in a box of oil, and thus pumping a fresh supply every moment. There are some anomalies in regard to bearings which it is nearly impossible to explain. Thus, a solid box has a permanency, certainly, as compared with any parted box, which cannot be accounted for.

I can hardly agree with the writer quoted by the Secretary, in the conclusions he has reached in regard to soft metals. The practice of all locomotive constructors is to use a brass box, perforated with holes and lined with soft metal, and I am not prepared to admit that that practice has not the warrantage of some reason. To be sure, some of the soft metals hold fragments of dust. But while this is the case with some, it is not true of all. Thus, lead, which is a tenacious metal, (each particle of fresh lead, as it leaves its bed or matrix, adhering upon a new or exposed surface anywhere, sticking in one mass readily,) is one of the most admirable materials for holding grit and sand; on the other hand, in zinc there is not the slightest tendency for abraded particles to re-adhere, nor does the metal form a lap to hold grit.

The metal known as Babbitt's is one of the best soft metals known.

This metal is composed of tin, zinc and antimony, is comparatively hard, unshrinking in cooling, and will not hold grit to any injurious extent.

Mr. Coleman Sellers said he would like to add a few words with reference to velocity and its effects. He instanced an experiment, made some years since, with a worm and worm-wheel hoisting machine. The machine had a constant and uniform load to hoist, viz: the weighed charges to the charging floor in an iron foundry. As first constructed and used, for a period of at least six years, hoisting at a given speed, and with the worm running at a given velocity, the engine driving the works was always slowed down by starting the hoister. In fact, there evidently was not power enough to work the machine successfully. A change was afterwards made in the machine, by increasing the size of the wire rope drum, to such an extent as to double the pressure on the worm and wheel, and therefore, to hoist at the same speed, the worm would have to revolve at one-half its former velocity. This change, and it only, so affected the running of the machine, that hoisting the same load at the same speed did not, in any case, have any noticeable effect on the speed of the engine.

In some experiments on screws, testing the principles on which they work, it was found a screw having one inch area, exactly, would work under seven thousand pounds to the square inch. It would probably have operated well to eleven thousand pounds, but the pressure actually applied was seven thousand pounds; while the pressure exerted to turn the screw should have raised a weight of nearly seventy thousand pounds instead of seven thousand. That is, the loss in friction was enormous.

In regard to the use of soft metals for bearings, for a number of years I had experience in a rolling mill, and was very much in favor of what was known as soft metal, in all its various forms. After that, for several years, I was engaged in the building of locomotives, and in brass boxes drilled holes, and filled them with soft metal. All the packing rings in cylinders were filled with soft metals. A great many engineers, however, have done away with this, using brass for boxes for journals and steel packing rings in the cylinder. The advantage in the use of the solid box has been one which has struck almost all engineers who have had any experience. There are examples, to which I could point, of solid boxes having been run for a great many years, in one case fifteen years, showing no appreciable wear under

severe work. Yet, the convenience of the split box, of course, necessitates its use in certain cases.

In regard to soft metals in rolling machines, I hope soon to have some very interesting information from the Superintendent of one of the largest rolling mills in the United States, in which soft metals have been used for many years, very advantageously.

Mr. William Sellers remarked, with reference to the length of bearings tried by Mr. Corliss and others, and reported as not having been found beneficial, or positively injurious, that the length of bearing may have been more apparent than real. This would be the case if no precautions were taken to allow the bearings to adjust themselves to the shaft. It is quite possible an increase of length in rigid bearings may prove detrimental, because the liability to bind upon the shaft will be increased with their length, but with bearings that adjust themselves to the shaft it is difficult, with our present knowledge of the laws of friction, to understand how an increase of length could prove injurious.

It may be interesting to state, with reference to vertical shafts, and the plan referred to by Mr. Briggs, of oiling them in the centre, that perhaps the first instance, certainly the first I know of, in which this plan was carried out, was in 1847, in a very large mill, in New England. The company had experienced a great deal of difficulty in running their upright shaft, at that time the largest in New England running at a high speed. I myself had gone to the mill, to put on a new step, upon the usual plan then in use, when, at the instance of Mr. William Mason, of Taunton, it was proposed to place a cast iron base-plate on foundations resting upon it, one of similar size, upon the shaft, making both very large, and so arranged that the oil could get up in the centre of the lower plate, and be distributed over the whole rubbing surfaces by groves on the revolving base, just as in a millstone. This plan was at that time very successful, and I have used it many times in my own practice since, with equally good results.

One reason why the solid box may be better than the split one, would support Mr. Briggs' view, and that is, the solid box will carry off the heat generated better than the split one.

Mr. Briggs. I cannot go back much further than 1845, '46 and '47, about which time I had cognizance of the difficulty mentioned by Mr. Sellers, and the remedy employed. But my own impression is, that it is a device known to old millwrights, who used many ver-

tical spindles. I cannot imagine that they did not overcome the difficulty which they must have encountered in the manner mentioned.

Mr. Coleman Sellers said: Oliver Evans, in his *Millwright's Guide*, mentions the necessity of getting heat away from journals, and shows that when the gudgeons of water-wheels are not properly arranged to carry heat away, it will act very injuriously.

Mr. Briggs. The first time I ever saw the great exaggeration of bearing so much used in America, was in some machinery erected by Thomas Hill, where the main line of shafting was run at a speed of two hundred and forty revolutions per minute. In that case, the length of bearings were five or six times the diameter of the shaft.

Mr. William Sellers. It is possible, as Mr. Briggs suggests, that the kind of step I referred to as having been originated by Mr. Mason, may have been used by some of the older millwrights, but we always find that expedients are devised whenever the necessity for them is discovered, and I doubt whether any of the older millwrights had any such necessity; therefore, I doubt the device having been employed by them. Their upright shafts almost always ran very slowly, and there are no records of any such step having been used by them.

[Report No. 805.]

Committee on Science and the Arts.

ON THE CENTRIFUGAL GOVERNOR.

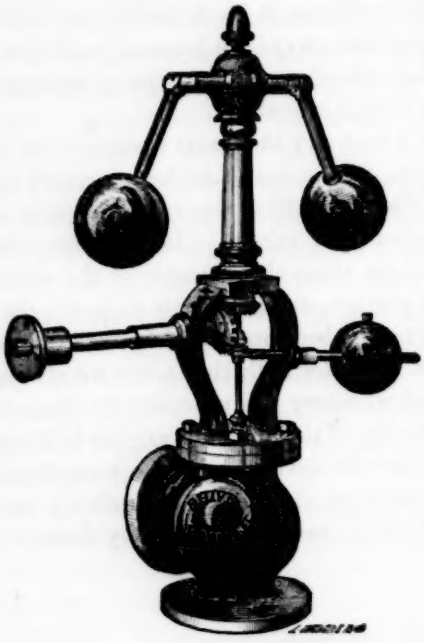
Invented by David Shive, Esq.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination the improvement in Centrifugal Governors invented by David Shive, of the City of Philadelphia,

Report, That the improvement above named consists in so suspending the arms or rods carrying the heavy balls, that they shall be free to move in a plane which occupies a position intermediate between one tangent and one radial to the circle of motion.

The advantages which it is proposed to secure by this means are as follows: Greater sensitiveness to slight changes of velocity, and a more prompt action as a result of this than can be secured by the ordinary form of governor in which the arms move radially, or in any other form heretofore employed. The reason of this superior efficiency in the points enumerated is stated as follows: Any change

in velocity must act initially in a tangential direction; hence, looking at this point alone, if the arms were supported by joints allowing a tangential motion, they would be in the best possible position for allowing the change in relative velocities of the supporting joint and ball to cause a change in inclination of the connecting-rod, which is the means of operating the valve. For in this case the change would act at once in the plane of motion allowed by the joint, and would experience no resistance by binding or jamming of the joint or guide.



If, however, the motion allowed by the joint were (as is usual) in a radial direction, then the first effect of a change of velocity would be to produce a pressure against the joint, and the outward or inward motion of the rods and balls would only occur as a secondary action or resultant of this resistance in the joint and the change of relative velocity. From these considerations it might appear that, regarding the change of velocity only, the best position of the joint would be that which allowed a tangential motion. Such would indeed be the case if the normal condition of the governor were of rest, and it simply started forward or backward with changes of velocity. But the rotary movement of the governor when in use develops a centrifugal force which would cause a constant strain or binding in the tangential joint, and for this reason it is found best to give the joint such a position that it will allow of a motion exactly half way between the radial and tangential direction.

In the opinion of the Committee, the governor for steam engines above described is ingenious in its arrangement and thoroughly efficient in its operation, giving far greater delicacy at low velocities than any other form of governor heretofore constructed, and being for this reason of decided practical value. This form is, moreover, as simple

in its parts, and as cheap in its construction, as that commonly employed.

By order of the Committee:

WILLIAM HAMILTON, *Actuary.*

Sub-committee of Examination: Washington Jones, S. Lloyd Wiegand, Emile Geyelin, Robert H. Lamborn.

Philadelphia, January 19th, 1867.

Bibliographical Notice.

THE ART OF PERFUMERY, and the Methods of Obtaining the Odors of Plants, &c., &c., with an appendix on preparing Artificial Fruit, Essences, &c. By G. W. Septimus Piesse. Second American, from the third London edition. Lindsay & Blakiston, Philadelphia, 1867.

The above work may be regarded as a hand-book and dictionary for the practical perfumer, offering him a vast amount of information as to the source and preparation of his ingredients, and many receipts and directions for their judicious combination; together with a theoretical discussion on odors and perfumery in general, by way of an introduction. With regard to this theoretical portion, we think that little can be said in commendation, though this, perhaps, is less the fault of the author than of the subject. About the cause of smell we know next to nothing; theorizing is therefore dangerous, because unguided. The particular theory here discussed and advocated, is that of an analogy between odor and music, similar to that which exists between light and sound. This is peculiarly unfortunate, for the little knowledge which we *do* possess as to odor, points in quite another direction. Heat, light and sound are all affections, or strictly, *motions* of matter, all and any of which, in all their individual variations, may exist in the same body in succession, without necessity of change in its material. Thus an iron wire may vibrate in succession a thousand different notes, may then emit a thousand various temperatures, and may, lastly, be caused to radiate every sort of light, and yet be nothing but an iron wire from beginning to end; but where is the body that will, unchanged, give us more than one perfume? The reason is clear. Perfume is not the result of a motion, which any mass of matter may assume, but the consequence of some special property, some peculiar form and arrangement of atoms (we know not what) which belongs in each case to a special substance, and cannot

be transferred to or from another. To arrange "smells," therefore, on a musical scale is a mere matter of fanciful and far-fetched analogy, without the shadow of a support in scientific fact. Far worse is it to confuse known actions with assumed nonentities, and to compare the mutual absorption of volatile acids and alkalies (which, becoming solid, in place of being gaseous, fail for *this* reason to affect the sense of smell) with the phenomena of "interference" in light and sound.

These theories, we are happy to say, however, occupy but a small space in the present work, and whatever is deficient in them is largely made up in the subsequent portions, which are filled with exactly what those purchasing such a book would look for and expect to find: facts and not fancies, statistics, not similies. We first find, in alphabetical order, full descriptions of all the perfume yielding substances, and their mode of preparation, embodying the various improvements which have been made in this direction, of late years. We have then, directions for the manufacture of smelling salts, perfumes, essences, soaps, cosmetics, oils, &c., &c., with every detail. Among these we notice some novelties, which are curious. Thus, at page 340, we read of a cosmetic which, rubbed upon the cheek or lips, though colorless at first, gradually turns to a deep rose color, from the action of the air. Among many other valuable suggestions, we note the following, on page 363. Sponge can decompose soap and clog itself with the grease. When rendered useless by this means, it may be cleaned by soaking for twenty-four hours in a lye of soda, and after rinsing and a second washing in water with a little muriatic acid, will be restored to perfect condition. Of the typography and binding we cannot speak too highly. It is everything that the most fastidious author or reader could ask. It is, indeed, such as would do credit to a merely ornamental publication.

WILL'S TABLES FOR QUALITATIVE ANALYSIS. Translated by Prof. Charles F. Himes, Ph.D., of Dickinson College, Carlisle, Penna.: Henry C. Baird.

THERE are some books, like some men, whom "to name is to praise;" and, moreover, in both cases, the extent of the fame and the simple *goodness* of the subject, sometimes makes the duty of the critic far from easy. Everybody knows the great and good man. How shall we rehearse his virtues and not be trite, especially if his goodness has kept him out of mischief and exciting incidents? Somewhat

such as this is our embarrassment in the present case. Will's Tables are used almost universally in the Chemical Schools of Germany, and thus most of our chemical readers will know, directly or indirectly, already, all we could say in their praise. Then, being thoroughly good chemical tables, we can make no entertaining discussion on their assumptions and their theories; for, knowing the duties of good tables to require eschewing of theories, &c., they have all such things accordingly eschewed.

To every student of analytical chemistry, however, young or old, and to every instructor in this branch, we can say, Will's Tables have been admirably put into English by Dr. Himes, and are published by Mr. Baird, who, we hope, will be able to fill the orders, which will come in when this fact is known, as fast as they will arrive.

THE ART OF MANUFACTURING SOAP AND CANDLES. Including the recent discoveries, &c., &c., and the making of Tallow and Composite Candles. By Adolph Ott, Ph.D. Lindsay & Blakiston, Philadelphia, 1867.

From another publication, bearing the name of Dr. Ott, we see that he comes to this country from the University of Turin, and we have thus explained to us certain peculiarities in the use of words, or liberties taken with the etymology of our language, which we may allow in courtesy to a foreigner, though we should take exception to the same at the hands of a countryman.

Making this little allowance, however, we shall find this work very clearly and pleasantly expressed, and rich with much new material not before offered to the reader in any collected form. The last improvements and patents in the branch of manufacture treated, are clearly and yet briefly stated, and many good wood cuts assist the explanations. One point we notice which needs filling up. It is stated that soda is prepared in *Europe* from cryolite. Our author is not, perhaps, aware that the Pennsylvania Salt and Alkali Company are importing and manufacturing six thousand tons, annually, in this country. There are many points of interest connected with this same manufacture, important to soap boilers, which we have not space here to relate.

A COMPARISON *of some of the Meteorological Phenomena of* APRIL, 1867, *with those of* APRIL, 1866, *and of the same month for* SIXTEEN *years, at Philadelphia, Pa.* Barometer 60 feet above mean tide in the Delaware River. Latitude 39° 57½′ N.; Longitude 75° 11½′ W. from Greenwich. By PROFESSOR J. A. KIRKPATRICK, of the Central High School.

	April, 1867.	April, 1866.	April, for 16 years.
Thermometer—Highest—degree	80·00°	82·00°	88·00°
" date	22d.	21st.	24th, '61.
Warmest day—mean	64·83	73·17	74·30
" " date	22d.	21st.	29th, '56.
Lowest—degree	36·00	37·00	20·00
" date	28th.	8th.	7th, '57.
Coldest day—mean	41·50	38·67	27·70
" " date	24th.	8th.	2d, '57.
Mean daily oscillation	17·75	14·17	16·40
" " range	6·54	6·09	6·23
Means at 7 A. M.	47·22	50·30	46·22
" 2 P. M.	59·92	61·28	57·86
" 9 P. M.	52·32	54·80	50·09
" for the month	53·15	55·46	51·39
Barometer—Highest—inches	30·314	30·252	30·518
" date	14th.	17th.	3d, '54.
Greatest mean daily pressure	30·289	30·203	30·458
" " " date	14th.	17th.	3d, '54.
Lowest—inches	29·295	28·820	28·820
" date	22d.	23d.	23d, '66.
Least mean daily pressure	29·516	29·051	28·959
" " " date	22d.	23d.	21st, '52.
Mean daily range	0·234	0·145	0·171
Means at 7 A. M	29·966	29·832	29·830
" 2 P. M	29·906	29·771	29·786
" 9 P. M	29·931	29·800	29·817
" for the month	29·934	29·801	29·811
Force of Vapor—Greatest—inches	0·504	0·605	0·689
" date	30th.	21st.	29th, '65.
Least—inches	·074	·094	·066
" date	6th.	9th.	13th, '52.
Means at 7 A. M	·213	·266	·233
" 2 P. M	·222	·302	·249
" 9 P. M	·241	·305	·253
" for the month	·225	·292	·245
Relative Humidity—Greatest—per cent	94·0	90·0	100·0
" date	30th.	19th.	Often.
Least—per cent	21·0	18·0	13·0
" date	6th.	29th.	13th, '52.
Means at 7 A. M	63·0	69·2	70·5
" 2 P. M	42·6	51·9	50·9
" 9 P. M	59·3	67·1	66·8
" for the month	55·0	62·7	62·7
Clouds—Number of clear days*	9·	7·	8·4
" cloudy days	21·	23·	21·6
Means of sky covered at 7 A. M	58·0 per ct	67·3 per ct	62·7 per ct
" " " 2 P. M	57·7	71·3	66·1
" " " 9 P. M	42·3	54·3	52·8
" " for the month	52·6	64·3	60·5
Rain—Amount—inches	1·360	2·922	4·479
No. of days on which rain fell	10·	10·	12·6
Prevailing Winds—Times in 1000	S 80° 8′ W·143	N74°45′W·141	N68°47′W·147

* Sky one-third or less covered at the hours of observation.

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